Atlantic Richfield Company

REMEDIATION MANAGEMENT
Atlantic Richfield Company
201 Helios Way
HPL 6th Floor
Houston, TX 77079

Paul F. Taylor
Strategy Manager – OB&C
Office (281) 366-6920
Fax (281) 366-7094
Mobile (713) 751-9439
paul.taylor2@bp.com

March 16, 2015

Mr. Galo Jackson
U.S. Environmental Protection Agency – Region IV
61 Forsyth Street
Atlanta, GA 30303

Sent Electronically

RE: LCP Chemical Site
Glynn County
Brunswick, GA

Dear Mr. Jackson:

On behalf of the Atlantic Richfield Company, attached are comments provided to EPA in response to the Agency's request for public comment on its Proposed Remedial Action Plan for the Marsh (OU1) at the LCP Brunswick Chemical Site. Please include Atlantic Richfield's comments in the administrative record for the Site.

Atlantic Richfield appreciates this opportunity to provide input into the administrative process.

If you have any questions, please let me know.

Respectfully,

Paul Taylor

Paul Taylor
Strategy Manager – OB&C Portfolio

Attachment

March 16, 2015

Atlantic Richfield Company Comments

United States Environmental Protection Agency (USEPA) Region 4

Superfund Proposed Plan

LCP Chemicals Superfund Site Operable Unit 1

City of Brunswick, Glynn County, Georgia

Atlantic Richfield Company (AR) offers the following comments for the Administrative Record on the USEPA Region 4's Superfund Proposed Plan for the LCP Chemicals Superfund Site (Site), Operable Unit (OU) 1, located in the City of Brunswick, Glynn County, Georgia. OU1 includes the 670+ acre tidal marsh and Purvis Creek system adjacent to the LCP property.

AR has been identified as one of the remaining, viable Potentially Responsible Parties (PRPs) at the Site, along with Honeywell International and the Georgia Power Company. AR's involvement as a PRP arose from one of its corporate predecessor's ownership and operation of an oil refinery and terminal on the LCP property between 1919 and 1955. As a PRP, AR has been involved in the thorough and lengthy remedial investigation/feasibility study (RI/FS) that has culminated in USEPA's Proposed Plan.

1. <u>Disagreement on USEPA's Assertions Regarding Potential Benthic Invertebrate Risks</u>

The USEPA includes an assertion in the Proposed Plan that there are risks to benthic invertebrate communities from the 4 designated chemicals of concern (COCs) in OU1. To that end, one of the Remedial Action Objectives established by USEPA for OU1 is to:

> *"Reduce risks to benthic organisms exposed to contaminated sediment to levels that will result in self-sustaining benthic communities with diversity and structure comparable to that in appropriate reference areas."*

This is based on flawed and highly uncertain conclusions in USEPA's Baseline Ecological Risk Assessment (BERA) for OU1 that do not comport with the results of site-specific studies that have been conducted to address potential risks to these organisms. These studies, which include both measures of sediment toxicity in laboratory assays, as well as benthic community surveys (i.e., collection, identification and counts of the organisms in sediments from various sampling locations), clearly demonstrate that there is no difference between the OU1 results and those from a reference/background study site in the Brunswick Estuary (facts that are acknowledged by USEPA both in the BERA and the Proposed Plan). Therefore, the "..*self-sustaining benthic communities with diversity and structure comparable to that in appropriate reference areas.*" identified as an RAO by USEPA has already been met within OU1 under current conditions and should be recognized as such.

In addition, statistical analyses of the sediment chemistry and toxicity data for OU1 in the BERA clearly showed that there are no demonstrable relationships between these factors for the identified COCs. As such, the USEPA's conclusion of risk to benthic communities within OU1 is incorrect, and the calculation of Preliminary Remediation Goals (PRGs) for benthic invertebrate communities was inappropriate. In fact, the OU1 BERA notes that the development of PRGs for the protection of benthic invertebrates is "highly uncertain with poor accuracies" and that "only conservative assumptions were used" for this purpose. The resultant PRGs were equivalent to the conservative sediment screening benchmarks. This conservatism and dismissal of the actual risk findings for the site is inappropriate in a baseline risk assessment under USEPA risk assessment guidance. AR recommends USEPA modify the administrative record to correctly reflect the lack of relationship between sediment chemistry and toxicity for the identified COCs when commenting on the current understanding of the actual risk associated with OU1.

2. <u>Disagreement with the Inclusion of PAHs and Pb as Risk Management Issues for OU1 in the Proposed Plan</u>

The USEPA clearly acknowledges that there are no findings of unacceptable risk to human health, fish or wildlife from PAHs or Pb in OU1 of the Site. These chemicals only remain as identified COCs due to the assertion by USEPA that they could possibly cause risk to benthic invertebrate communities, as discussed above.

AR believes that PAHs and Pb are very minor issues for OU1, as they do not pose a bio-accumulative (food web) unacceptable risk to humans, fish or wildlife of any kind or by any means of exposure, and their concentrations in the majority of the hundreds of sediment samples that have been collected within OU1 do not exceed either the conservative sediment benchmarks that are used by regulatory agencies as a means to rule out potential risk, or the respective PRGs that were established by USEPA from the BERA. While a low number of sediment samples collected in OU1 contained concentrations of PAHs and/or Pb that exceeded such screening benchmarks, that does not demonstrate risk. Instead, it suggest that further assessment of potential risk was warranted. That assessment came in the form of extensive sediment toxicity and benthic community measures (as described in comment 1 above). These site-specific measures showed toxicity levels and communities metrics that were comparable with the reference/background area studied. In the absence of the remedy being proposed to manage exposure to PCBs and Hg, AR believes that the distribution and concentrations of PAHs and Pb in the OU1 marsh/creek system would not warrant any further response action. As such, any reduction of exposure to PAHs and Pb achieved by the Proposed Plan is simply a minor added benefit of the remedy developed to address PCBs and Hg.

3. Agreement with the Superfund Recommended Alternative

AR believes that the recommended alternative within the USEPA's proposed plan is appropriate, sustainable, and protective of human health and the environment. The remedial action recommended in the proposed plan has been developed through a careful evaluation process that takes into account the extensive data and information collected at the Site over more than two decades including: conservative human health and ecological risk assessments performed by the USEPA; a previous large-scale (i.e., 13 acre) removal response action for the marsh (completed in 1999); and a detailed RI/FS that evaluates the range of potential remedial alternatives for OU1 all pursuant to the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA or Superfund) and utilizing evaluation criteria set forth in the National Contingency Plan (NCP). USEPA's proposed remedy will substantially reduce exposure to polychlorinated biphenyls (PCBs) and mercury (Hg) that have been determined by USEPA to pose an unacceptable risk to humans, fish and wildlife within OU1. It will also serve to reduce exposure to other chemicals that exist in sediments in portions of the marsh and creek (i.e., other metals and polycyclic aromatic hydrocarbons [PAHs]) that do not pose unacceptable risks to humans or fish/wildlife, but exceed conservative sediment screening levels in limited areas of OU1). A follow-up monitoring plan and Superfund Five Year Review process will be included as part of the Record of Decision (ROD) and serve to ensure remedy effectiveness post-implementation.

4. Agreement Regarding Primary Remedial Risk Management Drivers

The USEPA clearly and appropriately acknowledges in the Proposed Plan that the remedy is primarily based on management of potential risks from PCBs and Hg to humans, fish and wildlife (i.e., the primary risk drivers for the site), and that there are no findings of unacceptable risk to human health, fish or wildlife from other chemicals in OU1. AR agrees with this approach and focus.

AR appreciates USEPA's consideration of these comments and looks forward to USEPA's response and the final Record of Decision.

SOUTHERN ENVIRONMENTAL LAW CENTER

Telephone 404-521-9900

THE CANDLER BUILDING
127 PEACHTREE STREET NE, SUITE 605
ATLANTA, GA 30303-1840

Facsimile 404-521-9909

March 16, 2015

Via U.S. Mail and Electronic Mail

Mr. Galo Jackson
Remedial Project Manager
U.S. EPA Region 4
61 Forsyth Street, SW
Atlanta, GA 30303

Re: Comments on LCP Chemicals Superfund Proposed Plan

Dear Mr. Jackson:

We submit these comments on behalf of One Hundred Miles, the Satilla Riverkeeper, and the Altamaha Riverkeeper, as well as the collective memberships of all of these organizations. How the LCP Chemical Site is remediated is of great concern to each of these partner groups. We feel there are serious shortcomings in the U.S. Environmental Protection Agencies' (EPA) Superfund Proposed Plan for operable unit 1 of the Site, as well as the underlying Remedial Investigation and Feasibility Study prepared by the potentially responsible parties.

In short, the Proposed Plan is flawed in the following ways: i) the scope of the cleanup does not encompass all the contamination from the Site, ii) portions of the Site have not been adequately sampled, iii) the exposure levels are not sufficiently protective, iv) some alternatives would allow for the capping and covering of contaminants in place despite the very volatile marsh environment; v) no alternative discusses marsh restoration; vi) none of the alternatives take into account sea level rise; vii) none of the alternatives set forth a monitoring plan; and in the event the contamination caps and covers were to fail, the Proposed Plan does not specify what action would be taken to remedy the situation.

As part of our comments we have attached expert reports from Dr. Philip B. Bedient, P.E., Ph.D. and Loren Raum, Ph.D. These reports detail many of the flaws outlined above.

Background

The marsh component of the LCP Chemicals Site is approximately 700 acres in size. It is located in the Turtle River estuary immediately outside of Brunswick, Georgia. The Site primarily consists of tidal marsh and is divided in half, north to south, by Purvis Creek. Over the past 70 years, a number of industrial facilities operated on the Site, such as Atlantic Refining Company, Georgia Power, and Honeywell International Inc., and each one significantly contributed to the contamination of the Site's soil, groundwater, and marsh sediment. This section will briefly discuss the Site's history and cleanup progression.

In 1919, the Atlantic Refining Company owned and operated an oil refinery on the Site, the first manufacturing facility on record. The Georgia Power Company purchased portions of the land from the Atlantic Refining Company in 1937, 1942, and 1950 for electric power generating. From 1941 to 1955, the Dixie Paints and Varnish Company manufactured paint and varnish on the property. The Allied Chemical and Dye Corporation subsequently purchased most of the property (including the portions owned by Georgia Power and Dixie Paints and Varnish), and operated a chlor-alkali chemical plant. The primary purpose of this facility was to produce sodium carbonate from salt, ammonia, and carbon dioxide. In 1979, Linden Chemicals and Plastics (LCP Chemicals-Georgia, Inc.) acquired the Site and continued operating it as a chlor-alkali facility. LCP Chemicals ceased production in 1994.

As a result of decades of contamination, the EPA (through its federal enforcement power) ordered the previous property owners to begin cleaning up the Site in 1994. These previous owners, or potentially responsible parties, included the Atlantic Richfield Company, Georgia Power, and Honeywell. The following year, the state of Georgia designated the Site as its highest priority release, and requested that EPA add it to the National Priorities List. The National Priorities List is "a list of the most serious sites identified for possible long-term cleanup," and is based on the site's potential release of hazardous substances or contaminates.[1] LCP Chemicals was officially added to the EPA National Priorities List in 1996. Subsequently, from 1998-1999, EPA conducted its own removal action, removing over 200,000 tons of hazardous material and removing and

[1] U.S. Environmental Protection Agency, "Superfund Cleanup Process," *available at* http://www.epa.gov/superfund/cleanup/index.htm, (last visited Mar. 5, 2015).

restoring approximately 13 acres of marsh from the Site. The EPA and the potentially responsible parties agreed to share the cost of this removal effort.

After the National Priorities List designation and the removal action, the potentially responsible parties conducted a series of investigations in order to draft a remedial investigation report and feasibility study for the LCP Chemicals marsh area. Upon review of these documents, EPA issued a Proposed Plan for cleaning up the marsh, which includes a number of alternatives based on the findings from the Feasibility Study. In the Proposed Plan, EPA selected the "preferred" cleanup alternative. The public is permitted to submit comments, like the ones in this document, relating to that preferred alternative. Once the public comment period closes and EPA revises the Proposed Plan based on the public's feedback, the agency will issue a Record of Decision, which will explain the cleanup alternative ultimately selected for the LCP Chemicals Site.

Comments

I. The potentially responsible parties have drawn the boundaries of the area that needs to be addressed by the LCP Chemical Site cleanup too narrowly.

Although the property boundaries of the marsh portion of the LCP Chemicals Site may only encompass 700 acres, the breadth of contamination is far greater. The potentially responsible parties have left a legacy of contaminants that stretches far beyond the Turtle River estuary. A recent study conducted by the Agency for Toxic Substances and Disease Registry concludes that the specific PCBs used at LCP Chemicals, Aroclor 1268, is widespread in sediments around Brunswick.[2] The study revealed, for instance, that residents from Sapelo Island have been exposed to Aroclor 1268 and have elevated levels of PCBs in their bloodstreams as a result.[3] The most likely way that the residents became exposed to the Aroclor 1268 was by eating fish and other sea food that had consumed Aroclor 1268 from the LCP Chemicals Site. Sapelo Island is over 30 miles

[2] Backer, Lorraine and David Mellard, Polychlorinated Biphenyls (PCBs) in Georgia Coastal Environments and Populations, (Powerpoint slides), Agency for Toxic Substances and Disease Registry, p. 8 (Sept. 3, 2014).
[3] *Id.* at 26.

from the LCP Chemicals Site, so it is likely residents throughout the coastal Brunswick area are impacted as well.[4]

Before this cleanup advances, the potentially responsible parties should be required to address their full contamination legacy. The fish and other seafood that is currently contaminated with LCP Chemical contaminants will continue to be caught and consumed by recreational and subsistence fishermen. Even if institutional controls are instituted on a wider scale, as the ATSDR study recommends,[5] funds should be established for cancer victims in the Brunswick area and funds should be established for local food banks to compensate subsistence fishermen that depend on seafood for their protein. In addition to these measures, the potentially responsible parties should fund the natural resource damage projects required by the Natural Resource Trustees. Unless the potentially responsible parties undertake measures such as these, they will not make the public whole for injuries that may have occurred as a result of contamination from the Site.[6]

[4] It is well established that "the government need not trace or 'fingerprint' a defendant's wastes in order to recover under CERCLA." *United States v. Hercules, Inc.*, 247 F.3d 706, 716 (8th Cir. 2001), citing *United States v. Monsanto,* 858 F.2d 160, 169–70 (4th Cir. 1988).
[5] Backer at 26.
[6] Restoration Planning Scoping Notice, LCP Chemicals, Brunswick, Georgia (May 31, 2006).

II. The sampling on the Site is inadequate in areas such as Purvis Creek.

As Dr. Bedient commented in his expert report, the

> [s]ampling network used to delineate areas that need remediation is lacking in density and frequency. From figure 6-5 it is clear that approximately 50% of Purvis Creek has not been sampled for contaminants of concern. It is more likely than not that many of these non-sampled areas are contaminated with contaminants of concern.[7]

Without an adequate sampling network, the Site's contamination cannot be properly delineated. Before the Feasibility Study is finalized, the potentially responsible parties must complete an adequate sampling network and revise the Feasibility Study accordingly.

III. The exposure levels selected do not adequately protect human health and the environment.

In selecting remedial actions, the EPA is directed to establish acceptable exposure levels that are protective of human health and the environment and shall be developed by considering the following ... [f]or systemic toxicants, acceptable exposure levels shall represent concentration levels to which the human population, including sensitive subgroups, may be exposed without adverse effect during a lifetime or part of a lifetime, incorporating an adequate margin of safety.[8]

In performing this task for the LCP Chemical Site, the potentially responsible parties have failed to take into account site specific aspects of the Brunswick area and thus have based cleanup alternatives in the Proposed Plan on improper exposure levels.

For known or suspected carcinogens, acceptable exposure levels under the NCP are generally concentration levels that represent an excess upper bound lifetime cancer risk to an individual of between 10^{-4} and 10^{-6} using information on the relationship between dose and response.[9] In other words, one additional person in 10,000 to one additional

---

[7] Philip Bedient, Review of the LCP Chemicals Site, Brunswick, GA, Expert Report (Mar. 13, 2015) (Attachment A).
[8] 40 C.F.R. § 300.430(e)(2)(i).
[9] 40 C.F.R. § 300.430(e)(2)(i)(A)(2).

person in 1,000,000 will contract cancer as a result of exposure to the site. There is no requirement that a certain number of people be exposed. Rather, the NCP requirement is designed to protect an individual from an increased risk of contracting cancer as a result of exposure to hazardous substances.

A. The human health exposure levels are not protective enough.

1. The risk assessment underestimates the consumption of contaminated food.

The exposure level for human health was based in part on the number of seafood meals a subsistence fisherman would consume on a yearly basis. This number was "assumed" by the potentially responsible parties to be 40 meals per year.[10] This assumption was not based on any recent surveys of subsistence fishermen in the area.[11] Fortunately, there is a relevant study now. The ATSDR study mentioned above reveals that subsistence fishermen in the area consume up to 156 seafood meals a year—nearly four times the amount assumed by the potentially responsible parties.

Unless the potentially responsible parties take this differential into account and recalculate the exposure levels, they will be drastically underestimating the contaminants that will be consumed from the Site. In other words, subsistence fishermen have been and will continue to be exposed to more Aroclor 1268 and other contaminants from the Site than the Remedial Investigation report reveals.

The potentially responsible parties also erred in their treatment of adolescent subsidence fishermen. While it may be true that adolescent subsidence fishermen may fish less frequently than their parents, this has no bearing on how often they consume fish for supper. Most adolescents eat whatever ends up on the dinner table. Yet, the potentially responsible parties, for their risk modeling, contend that adolescent subsidence fishermen eat a full third less fish than their parents.[12] This does not square with reality and serves as another example of how the potentially responsible parties have underestimated the amount of exposure that subsidence fishermen would suffer even after the cleanup if it were done on the potentially responsible parties' terms. This is especially

[10] Proposed Plan at 16.

[11] Raun at 7.

[12] Human Health Risk Assessment for the Estuary, Operable Unit 1, Marsh Trespasser, Fish and Shellfish Consumer, Clapper Rail Consumer, Final, LCP Chemical Site, Brunswick, Georgia, Table 14a and Table 14b (Aug. 2011).

alarming considering that Site is very accessible to boats; as the Draft Feasibility Study states, boats up to 14 feet in length can access the Site using Purvis Creek.[13]

And the issue of subsistence fishing cannot be corrected by increasing fishing advisories. As other studies provide, subsistence fishermen do not pay attention to fishing advisories. "People are often aware of advisories, but continue to consume fish nonetheless (Reinert and other 1991, Burger and Gochfeld 1991, Burger and others 1992, 1993, Velicer and Knuth 1994, May and Burger 1996).[14] This is not surprising since fish "may be the main affordable source of protein."[15] And as Dr. Raun states in her expert report, "[f]ishing advisories will not keep hungry community members from eating contaminated seafood."[16]

2. The potentially responsible parties assumption that there has been a decrease in fish contamination is flawed.

The potentially responsible parties contend that the concentration of contaminants in fish has decreased, yet they offer no statistically significant evidence of this assumption. As Dr. Raun states in her expert report, the potentially responsible parties' contentions are largely overstated.[17] They are based on small sample sizes with limited statistical power, are unsophisticated, and tend toward bias.[18] Furthermore, the risk assessment does not acknowledge that a subsidence fisherman may eat more than one type of seafood, and the impact may be additive. As Dr. Raun points out in her report, "[t]his type of simplification is not protective with multiple contaminants impacting many different types of seafood."[19]

3. The potentially responsible parties did not take groundwater, surface water, and operable unit 3 into account.

The potentially responsible parties admit that contaminated groundwater is coming to the surface through seeps and mixing with surface water around the area that was

---

[13] Draft Feasibility Study at 10.
[14] Burger, Joanna, et al., Science, Policy, Stakeholders, and Fish Consumption Advisories: Developing a Fish Fact Sheet for the Savannah River, 27 Environmental Management No. 4 p. 502 (2001).
[15] *Id.*
[16] Raun at 10.
[17] *Id.*
[18] *Id.* at 8-9.
[19] Raun at 8.

remediated in 1999. They contend, however, that the surface water dilutes the contamination to such an extent that it is not a factor. Dr. Raun disagrees. She views the increased levels of contamination in the formerly remediated area as evidence that whatever dilution that is taking place is not sufficient offset the groundwater contamination.[20] The potentially responsible parties must demonstrate that contaminated groundwater is not a problem at Site, or develop a plan for addressing it.

Additionally, the risk assessment does not take into account other pathways aside from fish consumption. As Dr. Raun states in her report,

> [r]isk assessment requires that all exposure pathways for a receptor be considered. . . . In other words, the risk for the high rate consumer should be added to the risk of receptors considered in the OU3 risk assessment, and RGOs developed based on the added risk. While it is acceptable to separate the contamination into operable units for management, it is not justifiable to consider the risk in an operable unit in a vacuum.[21]

For example, a subsidence fisherman could well be a trespasser on operable unit 3. The risk assessment must take into account both contaminant pathways. Similarly, the risk assessment does not take into account exposure to contaminated surface water and sediments from the Site. As Dr. Raun states in her report, "Any risk added from these other pathways would result in lower [remedial goals]."[22]

B. The ecological exposure levels are not protective enough.

In addition to using numbers that artificially reduce the exposure levels to humans, the potentially responsible parties have done the same for the environment. Starting in 2006, the Georgia Department of Natural Resources, NOAA Fisheries, and the National Ocean Service began to test bottlenose dolphin in the Brunswick area for PCB contamination. In particular they focused on Aroclor 1268.[23] As the study provides, "[b]ottlenose dolphins are ideal sentinels for coastal ecosystem health because they are top predators that are long-lived and tend to accumulate persistent environmental

[20] Raun at 5.
[21] *Id.* at 3.
[22] *Id.*
[23] Georgia Department of Natural Resources, Bottlenose Dolphin Contaminants Project, http://www.georgiawildlife.org (last visited Feb. 26, 2015).

contaminants in their lipid-rich blubber."[24] The findings of the study reveal that the dolphins tested had concentrations of Aroclor 1268 ten times higher than any location previously documented.[25]

Even though the dolphin study was ongoing, was investigating the precise contaminant at issue at the LCP Chemical Site, and involved the "ideal sentinel for ecosystem health," the potentially responsible parties did not incorporate the data in their risk assessment. Nor did they test any dolphins themselves, even though they acknowledge that dolphins do visit the Site via Purvis Creek, the main tidal creek that connects the Site to Turtle River.[26] Instead of testing dolphins, the potentially responsible parties chose marsh rabbits, river otters, and raccoons for their ecological risk assessment.[27] The potentially responsible parties should be required to redo their ecological risk assessment so that it either incorporates existing data from the dolphin study or incorporates new data gathered by the potentially responsible parties.

The potentially responsible parties set as one of their remedial action objectives to "reduce piscivorous [fish eating] bird and mammal population exposure to [contaminants] from ingestion of prey exposed to contaminated sediment in the LCP Chemicals marsh to acceptable levels, considering spatial forage areas of the wildlife and movement of forage prey."[28] Yet the potentially responsible parties did not include the piscivorous mammal most prone to bioaccumulation in any of its analyses—the bottlenose dolphin.[29] This flaw must be corrected.

C. The exposure range selected is not acceptable.

Not only did the potentially responsible parties underestimate the amount of risk associated with exposure to the contaminants of concern, they then selected exposure levels based on the absolute lowest allowable risk factor—an additional cancer victim in every 10,000 people (1E-04).[30]

---

[24] *Id.*
[25] *Id.*
[26] Draft Feasibility Study at 12.
[27] Proposed Plan at 21.
[28] Proposed Plan at 23.
[29] Draft Feasibility Study17 and 18.
[30] Proposed Plan at 24.

As the potentially responsible parties report in the draft feasibility study, "[o]nly the high-quantity fish consumer scenario has an ELCR estimate that exceeds USEPA's target risk range of 10^{-6} x to 10^{-4} and that estimate is 2×10^{-4}."[31] In other words the potentially responsible parties have proposed an exposure level for subsidence fishermen twice as high as EPA typically accepts. According to EPA guidance, to have a target risk of less than 1×10^{-4}, there must be site specific reasons that support such a departure.[32] The potentially responsible parties provide no site specific reasons that would justify such a change. Thus, not only have the potentially responsible parties underestimated the number of fish meals that subsidence fishermen eat per year, but they have compounded the problem still further by subjecting subsistence fishermen to higher exposure levels.

D. The potentially responsible parties want to leave contaminant hot spots in the marsh.

To compound the exposure level flaws still further, the potentially responsible parties also apply a concept called "surface weighted average concentration" which would, if the Proposed Plan were to go through, leave hot spots of contamination in the marsh.[33] Instead of cleaning the entire marsh up to a set level of contamination, the potentially responsible parties are proposing to leave areas of higher contamination in the marsh because they are more difficult to dredge. This is unacceptable. The potentially responsible parties should not be allowed to ignore contaminated areas because they are hard to reach.

IV. The thin layer cover approach used in Alternative 2 is inappropriate for this Site.

A. The Site is a volatile marsh environment unsuitable for a thin layer cap.

In the Superfund Proposed Plan, the U.S. Environmental Protection Agency and the Georgia Environmental Protection Division (the Agencies) provide, "[t]he Turtle River water surface elevation can vary in excess of nine ft during a tidal cycle."[34] In the Draft Feasibility Study, the potentially responsible parties acknowledge that "[t]idal

---

[31] Draft Feasibility Study at 21.
[32] *Id.* at 20.
[33] Proposed Plan at 24.
[34] U.S. Environmental Protection Agency, Superfund Proposed Plan, LCP Chemicals Superfund Site, Operable Unit 1, Nov. 2014, at 3.

hydrodynamics have a significant effect on the transport of waterborne substances (e.g., suspended sediment, chemicals) within the Site." And that the 7-8 foot tide range "produces strong vertical mixing in the water column and a relatively long horizontal excursion of water."[35] The potentially responsible parties state further that "[c]urrent velocities are relatively high within the tidal creeks during flood tide."[36] Lastly, the potentially responsible parties admit that "[s]ediment erosion is likely to occur in some portions of the tidal creeks during spring tide conditions because peak current velocities are high enough . . . to exceed the critical shear stress of surface sediments . . . ."[37]

Despite the above descriptions of the Site that reveal it is a highly volatile environment, the potentially responsible parties contend that they can cover contaminants in place with a six-inch layer of sand and that it will all hold together through high tides, hurricanes, and storm surges.[38] As the EPA has stated in guidance, "[t]ypically, sand caps are used in low velocity waterways to protect them from scouring by strong (high energy)

---

[35] Draft Feasibility Study at 8.
[36] *Id.* at 8.
[37] *Id.* at 9.
[38] Brunswick is no stranger to hurricanes and tropical storms as the following records document:

> 1874 Sept. 28th a hurricane from the SW stays just offshore with 80mph winds
> 1878 Sept. 12th just offshore moving north 90 mph
> 1885 Aug. 25th just offshore 105mph while moving north
> 1893 Aug. 28th a major hurricane with 115 mph winds just east kills over 2,000 in Georgia & Carolinas, reports had downtown Brunswick under 6 ft. of water for up to 12 hrs., offshore of St. Simons Island by 25-30 statute miles. . . .
> 1893 Oct. 13th just off shore while moving NNE 120 mph winds
> 1896 Sept. 29th a cat 2 110 mph passes over while moving N.E. Winds caused very heavy damage in the area.
> 1898 Oct. 2nd, 130 mph from the S.E. a hurricane leaves area under 4 ft. of water Oct. 2nd scores drowned. Winds east at 135 mph and data suggest that this Hurricane may have been the size of Hugo (1989 S Carolina). Calm reported at 11 am, Dunn and Miller reported 179 killed in coastal Georgia and 16 foot storm surge in downtown Brunswick. . . .
> 1928 Sept 18th from the south just inland with 90 mph winds
> 1968 tropical storm Abby 60 mph minor damage
> 1979 Sept 4th David to east by 30 miles with 85 mph winds minor damage.
> 1981 tropical storm Dennis to east with 50mph winds minor damage
> 1984 tropical storm Isadore passed over the area from the south west with 45mph minor damage.

Glynn County, Brunswick, Georgia's history with tropical systems, http://www.hurricanecity.com/city/brunswick.htm (last visited Feb. 27, 2015).

currents.[39] As mentioned above, the potentially responsible parties admit that there will be erosion along tidal creeks on the Site. As one study involving a Georgia marsh reported, roughly 10 to 25% of the marsh surface is occupied by creek banks and tall S. alterniflora zones.[40] With tidal creeks occupying so much surface area in Georgia marshes, there is plenty of opportunity for extensive scouring on the LCP Chemical Site.

Furthermore, as Dr. Bedient provides in this comments, the Site conditions simply are not suitable to a thin layer cap.[41] As he states,

> Placing a cap or thin sand cover on top to the contaminated sediment in the marsh would not prevent such erosion/scour given the volatile nature of the tidal regime and water level fluctuations during storm events (see Figure B3-15 from the Feasibility Report June 2014), especially since there is no tie-in into the existing marsh sediment so as to completely contain the contaminated sediment from being able to migrate.[42]

In short, the LCP marshes are no place for a thin layer cap.

Nonetheless, to support their choice of a thin layer placement approach, the potentially responsible parties include in the Draft Feasibility Study eight case studies of other remediations that have used this cover-in-place method; however, not one the projects combined 6 inch sand cover, a marsh environment, and a 9 foot tide. Furthermore, some of the projects were totally dissimilar and involved putting the thin cover on the floor of the rivers, inlets, or harbors.[43]

The remediation performed at one of the case studies, Bremerton Naval Complex, for example, involved thin-cover placement on the bottom of Sinclair Inlet offshore from a naval shipyard.[44] And the effectiveness of the project is still being evaluated.[45] Another

---

[39] EPA, Contaminated Site Cleanup Information, http://clu-in.org/contaminantfocus/default.focus/sec/sediments/cat/Remediation/p/1 (last visited Feb. 22, 2015).
[40] Gribsholt, Britta, et al. Impact of fiddler crabs and plant roots on sediment biogeochemistry in a Georgia saltmarsh, 259 Mar. Ecol. Prog. Ser. 248 (Sept 12, 2003).
[41] Bedient at 4.
[42] *Id.*
[43] Draft Feasibility Study at 53.
[44] Merritt, K. et al., Enhanced Monitored Natural Recovery (EMNR) Case Studies Review, Technical Report 1983, p. 16, (May 2009).
[45] *See*, USGS, Sources of Mercury in Sinclair Inlet, http://wa.water.usgs.gov/projects/sinclair (last visited Feb. 24, 2015).

case study, Grasse River, involved the placement of a 12-inch cap on the bottom of a freshwater river.[46] A third involved another subaqueous cap in Eagle Harbor in Pugent Sound.[47] A fourth involved a 9-12 inch thick cap placed at the bottom of the Lower Duwamish Waterway, in Washington. And a fifth involved the placement of a cap at a depth of 120 feet in Ward Cove in Alaska. This cap was placed over sediments that were already within human health and environment limits.[48]

The remaining case studies involved thin layer caps that were placed on tidal flats, but none involved the volatile marsh environment contemplated here. In short, the thin-cover placement technology is still in its infancy when it comes to the marsh environment. The eight case studies the potentially responsible parties have offered up are all too dissimilar from the LCP Chemicals Site to offer much comfort that a thin layer cap will perform adequately at the Site. As Dr. Bedient commented in his expert report, "[t]he experience that these concepts may have at other sites is not relevant to this site if the other sites do not have the kind of tidal regime and flood/hurricane conditions that exist at this site."[49]

If there are projects in which the thin layer cap approach has been used successfully in a marsh environment, the potentially responsible parties should be required to document these successes in the final feasibility study and discuss how those successes demonstrate that a thin layer cap could work in the volatile LCP Chemical environment. While the potentially responsible parties are correct when they say "[t]hin-cover placement is a readily implementable technology, *particularly in low-energy areas not subject to scour or erosion . . .* ,"[50] with its 9 foot tide range, the Site cannot be considered "low energy."

B. The integrity of the thin layer cap will be compromised by bioturbation.

While the potentially responsible parties acknowledge that the thin cover cap will have holes poked in it by marsh organisms that will come to inhabit it, they do not consider that a problem. The potentially responsible parties contend that most of the organisms that would perform such work would be confined to the top 4 inches of the

---

[46] Merritt at 26.
[47] *Id.* at 3.
[48] *Id.* at 7.
[49] Bedient at 5.
[50] Draft Feasibility Study at 54.

cover.[51] Yet, the potentially responsible parties state earlier in the Draft Feasibility Study that "fiddler crabs are ubiquitous in salt marshes."[52] One study reported that as many as 500 fiddler crabs can inhabit a square meter of marsh.[53]

Because of their numbers, "fiddler crabs are one of the principal agents of bioturbation in interlude salt marshes."[54] And fiddler crabs burrow far more deeply than 4 inches. The burrows typically range up to 10 inches in depth.[55] As the EPA has stated in guidance, "[t]he cap has to be at least as thick as the large populations of burrowing benthic organisms to keep them from becoming contaminated."[56] Thus, fiddler crabs on the LCP Chemical Site would regularly penetrate the 6 inch cap. As Dr. Bedient states in his report: "6 inches of sand is not sufficient to prevent sediment dwelling organisms from borrowing into and through the sand so as to expose the contaminated sediment to erosion."[57] In light of this bioturbation, the six-inch thin cap is unsuitable for this remediation.

C. The potentially responsible parties ignore sea level rise.

If the sea level rises at the rates estimated, 1-2 feet over the next 100 years,[58] the entire LCP Chemical marsh could be drowned out and replaced with mudflats. Although the potentially responsible parties contend that the Site is a "net depositional zone" because the marsh grass acts to slow the velocity of the tidal waters,[59] they need to evaluate if that were the case if the marsh grass were no longer present. Because the Draft Feasibility Study only explores the current conditions of the marsh and fails to include any discussion of how those conditions will likely change over time, it is inadequate and fails to discuss a long-term solution.

---

[51] *Id.* at 52.
[52] *Id.* at 11.
[53] Gribsholt at 238.
[54] McCraith, Barbara J., et al., The effect of fiddler crab burrowing on sediment mixing and radionuclide profiles along a topographic gradient in a southeastern marsh, 61 Journal of Marine Research, 359, 359 (2003).
[55] Gribsholt at 238.
[56] EPA, Contaminated Site Cleanup Information, http://clu-in.org/contaminantfocus/default.focus/sec/sediments/cat/Remediation/p/1 (last visited Feb. 22, 2015).
[57] Bedient at 4.
[58] *Id.* at 4.
[59] Draft Feasibility Study at 8.

D. Summary of flaws with thin cap technology.

Dr. Bedient summed up his analysis of the thin layer cap application in the following:

The proposed cap will probably fail for [the] reasons listed below:

- Destruction of capping/cover material by scouring due to tidal action.
- Destruction of capping/cover material by hurricane type storms.
- Destruction of capping/cover material by changing hydraulic conditions due to sea-level rise.
- Destruction of capping/cover material by changing environmental conditions typically associated with meandering creeks within delta systems.
- Destruction of capping/cover material by sediment dwelling organisms.
- Lateral movement of contaminants within the subsurface sediment has not been addressed.[60]

In short, thin-cover placement is not an implementable technology for the LCP Chemicals Site and should not be used.

VI. The Draft Feasibility Study is incomplete because it does not include any alternatives that incorporate marsh restoration.

The potentially responsible parties admit that 700 acres of the marsh are contaminated to a level that would in certain circumstances trigger a cleanup of all 700 acres.[61] But then the potentially responsible parties explain that such a cleanup at this Site is not practical because it would cause "unwarranted harm" to the marsh.[62] Even the cleanup of 81 acres of the marsh was deemed so excessive that it was not even considered in the alternative cleanup approaches.[63] What is conspicuously lacking from this discussion is mention of any form of marsh restoration.

---

[60] Bedient at 7.
[61] Proposed Plan at 24.
[62] *Id.*
[63] Proposed Plan at 25.

In their analysis, the potentially responsible parties simply assume that if they were to dredge areas of the marsh that they would have to be left in that state with perhaps some minimal backfilling. By failing to discuss what would be involved in restoring any dredged areas with adequate sediment replacement and replanting, the potentially responsible parties have failed to complete an adequate Draft Feasibility Study. This failure is particularly conspicuous considering that during the removal action on the Site, the EPA demonstrated that it could successfully dredge contaminated sediments from the marsh, backfill the dredged area, and replant the marsh. The EPA performed this restoration on the 13 most highly contaminated acres of the marsh.[64] The Draft Feasibility Study and the Proposed Plan are completely devoid of any explanation as to why the potentially responsible parties could not do what EPA has done, dredge, backfill, and restore the marsh.

From the description of the 13-acre marsh restoration that was conducted in 1998-99, the restoration was highly successful. As the Draft Feasibility Study reports, "[w]ithin two years after remediation, *Spartina* filled the remediated area of the Site . . . . After three to four years, the area was virtually indistinguishable from the surrounding marsh . . . ."[65] The Draft Feasibility Study goes on to state that "[t]hese site-specific restoration time frames are consistent with other observations noted for created salt marsh sites."[66]

As the potentially responsible parties acknowledge, the "removal of sediment by dredging or excavation has been demonstrated at numerous sites" and is a "mature" technology,[67] and the "industry and the region have substantial experience" with this form of remediation.[68] The industry is also developing experience in how to regrow marshes. In addition to the marsh that was regrown on Site, there are numerous successful marsh restoration projects across the country.[69] The potentially responsible parties should be required to explain in the Draft Feasibility Study why it did not incorporate marsh restoration into the alternatives it outlined.

---

[64] *Id.* at 6.
[65] Draft Feasibility Study at 14; Raun at 10.
[66] *Id.* at 14.
[67] *Id.* at 63.
[68] *Id.* at 63.
[69] See, e.g., Florida Department of Environmental Protection, Project Greenshores, http://www.dep.state.fl.us/northwest/Ecosys/section/greenshores.htm (last visited Feb. 27, 2015).

Such analysis is particularly important considering that the potentially responsible parties rely so heavily on the concept that thin cover placement is better than dredging and backfilling the Site because a thin cover cap would have fewer short-term impacts on the marsh. But in reaching this conclusion, the potentially responsible parties are making an apples to oranges comparison. They should be comparing the thin layer cap to a dredged, backfilled, and *replanted* marsh. Because the Draft Feasibility Study does not include such a comparison, it is incomplete.

VIII. The Proposed Plan and the Draft Feasibility Study provide for inadequate information on monitoring.

As Dr. Bedient provides in his expert report, considering the nature of the thin layer cap and its vulnerability to hurricanes, tides, and storm surges, the Proposed Plan and Draft Feasibility Study should include more detailed information on monitoring.[70] For example, other thin layer cap sites have instituted monitoring plans that operate on a two-year interval.[71] Will the potentially responsible parties adopt such an interval or not? Furthermore, there is no discussion in the Draft Feasibility Study or the Proposed Plan that explains what course or courses of action will take place in the event one or more elements of the remediation were to fail. By failing to include such details, the EPA and the potentially responsible parties have denied the public its right to comment.

IX. The cap-in-place alternatives should be discarded because they do not provide a permanent solution.

The National Contingency Plan provides as follows:

> (E) Each remedial action shall utilize *permanent* solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable.[72]

Because the LCP Chemicals Site is so volatile, is subject to sea level rise, and is subject to bioturbation, it is unlikely that the thin layer caps will survive long-term.[73] Thus, it should not be considered for the LCP Chemical Site.

---

[70] Bedient at 5.
[71] *See e.g.*, Merritt at 6.
[72] 40 C.F.R. §300.430 (f)(1)(ii)(E) (emphasis added).
[73] Bedient at 6.

The EPA was faced with a very similar situation to the one here involving a contaminated river in Wisconsin. One alternative involved the removal of sediment from the bottom of the river. Another involved capping that sediment in place. Even though the sediment removal option was more expensive, the EPA opted for the more permanent solution. The Seventh Circuit Court of Appeals, which eventually heard an appeal on the case, reported on the district court decision as follows:

> The district court concluded that the agencies' decision to maintain a preference for dredging in the amended remedy was rationally related to the facts before them. In particular, the court noted that dredging represents a more permanent solution because it actually removes PCBs from the Site, while capping and sand covering merely contain PCB-contaminated sediment. Moreover, capping and sand covering require long-term monitoring to ensure their effectiveness, and they are susceptible to failure during catastrophic events like floods. Ultimately, the district court concluded that the agencies acted rationally by adopting "a mild preference for the benefits of dredging and viewed these as being worth their added expense." We agree.[74]

Thus, the EPA's decision to go with the more expensive permanent solution was upheld. Similarly, if EPA were to adopt a similar course in this case, that decision too would be upheld. As this same district court explained

> Specifically, it provides that "the court shall uphold the President's decision in selecting the response action unless the objecting party can demonstrate, on the administrative record, that the decision was arbitrary and capricious or otherwise not in accordance with law." This means that the government's selected response action is presumed valid unless the Defendants can meet their burden to demonstrate otherwise.[75]

The court went on to explain that "the Defendants [had] an uphill battle: no matter how one spins it, they were demanding that more poisonous chemicals be allowed to *stay* in the River."[76] Likewise, if any of the potentially responsible parties were to challenge an EPA decision to abandon the thin layer cap approach, they would have to argue for leaving contaminants in the marsh.

---

[74] *United States v. P.H. Glatfelter Co.*, 768 F.3d 662, 670 (7th Cir. 2014), *reh'g denied* (Nov. 19, 2014).
[75] *United States v. NCR Corp.*, 911 F. Supp. 2d 767, 773 (E.D. Wis. 2012) *aff'd sub nom. United States v. P.H. Glatfelter Co.*, 768 F.3d 662 (7th Cir. 2014) (citations omitted).
[76] *Id.* at 786.

There is no requirement in the NCP that EPA select the lowest cost alternative that is consistent with the plan. As the district court for the Eastern District of Arkansas explained:

> Response costs that are not inconsistent with the NCP are conclusively presumed to be reasonable and therefore recoverable under CERCLA. See *United States v. Dico,* 266 F.3d 864, 879 (8th Cir.2001); *United States v. Findett Corp.,* 220 F.3d at 849; *United States v. Hardage,* 982 F.2d at 1441-1443; *United States v. Northeastern Pharm. and Chem. Co., Inc.,* 810 F.2d at 747-48 (8th Cir.1986); *United States v. Vertac Chem. Corp.,* 33 F.Supp.2d 769, 777 (E.D.Ark.1998); *United States v. Gurley,* 788 F.Supp. at 1481. The focus of the NCP is on procedures for the selection of response action rather than on "costs", per se:
>
> > The NCP regulates *choice of response action, not costs.* Costs, by themselves, cannot be inconsistent with the NCP. Only response actions-i.e., removal or remedial actions-can be inconsistent with the NCP, which can be demonstrated by a showing that the government's choice of response action was arbitrary and capricious. As long as the government's choice of response action is not inconsistent with the NCP, its costs are presumed to be reasonable and therefore recoverable. *Hardage,* 982 F.2d at 1443 (emphasis in the original).[77]

Thus, the EPA, in making its final selection of a remedy for the LCP Chemicals Site, can and should do what it did in the river site described above, choose permanency over price.

Conclusion

Before EPA is in a position to make any choice concerning a remedy, however, the potentially responsible parties must fix the multiple flaws in the remedial investigation and feasibility study documents. The scope of the cleanup must address the fact that PCBs and other contaminants from the Site have migrated out of the Turtle River. The exposure levels must be accurately calculated. The thin layer cap must be abandoned. Sea level rise must be taken into account. Marsh restoration scenarios must be factored in. And EPA must make a choice of remedy not based on price, but on the best remedy consistent with the National Contingency Plan.

[77] *United States v. Gurley,* 317 F. Supp. 2d 870, 878 (E.D. Ark. 2004) *aff'd,* 434 F.3d 1064 (8th Cir. 2006).

In responding to these comments, we ask that you also address any comments made in the attached expert reports.

Thank you for providing us with this opportunity to comment on this important project.

Sincerely,

William W. Sapp

William W. Sapp
Senior Attorney

cc: Megan Desrosiers, One Hundred Miles
Ashby Nix, Satilla Riverkeeper
Jen Hilburn, Altamaha Riverkeeper

ATTACHMENT A

Review of the LCP Chemicals Site, Brunswick, GA.

By Philip B. Bedient, P.E., Ph.D.

March 13, 2015

Philip B. Bedient

PBBedient

P. B. Bedient and Assoc., Inc

Review of the LCP Chemicals Site, Brunswick, GA.

I was retained on this project for the purpose of evaluating the potential contaminant transport from the LCP Chemicals Site into the Turtle River estuary system, here forth referred to as "the Site". My opinions are based on my professional experience in hydrogeology, environmental engineering, hydrology and hydraulics, and review of relevant data, maps, aerials, documentation to date, and are subject to change if and when additional information becomes available.

Section I. Qualifications

My educational background, research and professional experience and the review of documents provided are the basis of my opinions. I hold the Ph.D. degree from the University of Florida in Environmental Engineering Sciences, and I have attached a curriculum vita including a list of peer-reviewed publications. I am the professor of Civil and Environmental Engineering at Rice University, where I have been on faculty since 1975, and teach courses in hydrogeology, hydrology, floodplain analysis and hydrologic modeling. I have written two major textbooks, one on hydrogeology and one on hydrology. I have worked at over 30 hazardous waste sites and military bases nationwide since 1981 including over 12 Superfund Sites. I currently hold the following positions: Herman Brown Professor of Engineering, Fellow of ASCE, Diplomat of the American Academy of Water Resources Engineers, and the Director of the Severe Storm Prediction, Education, and Evacuation from Disasters (SSPEED) research center at Rice University. I am a registered professional engineer in Texas and a registered professional hydrologist.

Section II. Site History and Description

Use began in 1836 with construction of the Brunswick-Altamaha Canal along the uplands and the marsh boundary.

ARCO used Site as a refinery from 1919-1929.

Georgia Power operated an oil-fired power plant from 1937 through 1950.

Dixie Paint and Varnish Co. purchased part of the Site in 1941 and operated a manufacturing facility until 1955.

Allied Chemical purchased the Site in 1955 and constructed and operated a chlor-alkali facility, utilizing the mercury-cell process. Main products were chlorine gas, hydrogen gas, and sodium-hydroxide solution

LCP Chemicals purchased almost all of the Site in 1979 and continued to operate the chlor-alkali facility until 1994, when operations were discontinued. In May 1998, Allied Signal (Honeywell) purchased the LCP property from the estate in bankruptcy.

The LCP site occupies approximately 813 acres of tidal marshland and dry land northwest of Brunswick, Georgia, along the Turtle River estuary system.

Section III. Chemicals of Concern

- Mercury (including methylmercury)
- PCB (Aroclor 1268)
- Lead
- Polycyclic Aromatic Hydrocarbons (PAHs)

Section IV. Comments on Proposed Remedial Measures

1. **The cap/thin sand covering are subject to erosion/scour and/or failure given the volatile tidal regime in the area**

This site is located within a marsh of about 700 acres that is split by Purvis Creek, a tributary to Turtle River, and is subject to daily tides that can fluctuate from about 6 feet below mean sea level to as much as 4 feet above mean sea level (see Figure B2-18 from the Feasibility Report June 2014). Given that the marsh has a surface elevation of about 2-3 feet above mean sea level (see Figure B2-4), this means that the marsh is subjected to inundation and filling with high tide and to draining with low tide, twice a day. As such, the sediment in the marsh would be subjected to erosion/scouring and to being transported around, into and out of the marsh, both during tidal activity, as well as during rainfall/runoff conditions, especially during heavy rainfall events, floods and hurricanes. Placing a cap or thin sand cover on top of the contaminated sediment in the marsh would not prevent such erosion/scour given the volatile nature of the tidal regime and water level fluctuations during storm events (see Figure B3-15 from the Feasibility Report June 2014), especially since there is no tie-in into the existing marsh sediment so as to completely contain the contaminated sediment from being able to migrate.

2. **The cap/thin sand covering concepts are subject to disturbance by sediment dwelling organisms that inhabit the marsh area**

The thickness of the proposed cap concepts of about 6 inches of sand is not sufficient to prevent sediment dwelling organisms from borrowing into and through the sand so as to expose the contaminated sediment to erosion.

3. **The cap/thin sand covering concepts are subject to increased inundation due to sea level rise**

The proposed cap concepts do not recognize nor address the impact of sea level rise on the long-term effectiveness of these concepts to prohibit the escape of contaminants within the marsh. Estimates of sea level rise of from 1-2 feet over the next 100 years have been presented (e.g. from the USACE). Such change in the normal water levels in the area will inherently result in changes to the topography of the site and the nearby rivers, streams, creeks, and gullies that have not been evaluated as to the long-term effectiveness of the proposed concepts.

4. **The cap/thin sand covering concepts will require long-term monitoring to ensure effectiveness**

These remedial concepts will require long-term monitoring to ensure that they are effective in containing and/or remediating the contaminated sediment at the site. There are no details as to what such monitoring will entail, as well as what actions would be taken if it is determined that these concepts are not working or fail.

5. **Movement of contaminants from under the thin sand layer is possible given the interaction of groundwater with the surface water in the marsh and the fluctuation of the tides in this area**

Given the evidence that there is groundwater interaction with the surface water and the marsh in this area, these concepts do not prevent such interaction from continuing, such that contaminants will continue to move out of the marsh and into the groundwater and surface water in the area.

6. **Previous experience at other sites not similar to this site given its volatile tidal regime in relation to the topography**

The experience that these concepts may have at other sites is not relevant to this site if the other sites do not have the kind of tidal regime and flood/hurricane conditions that exist at this site.

7. **The proposed cap areas along Purvis Creek seem to be selected based on limited sampling**

The location of dredge areas and proposed cap areas along Purvis Creek are based on the results of the selected samples taken along portions of the creek (see Figures 5-2 and 6-1C). However, there are numerous areas where no samples were taken, near to where there were samples showing high contaminant levels that will receive caps (see Figure 6-5). In addition, there were samples taken adjacent to one another that showed one to have high levels of contamination and the other did not. This suggests that the extent of contamination is extremely variable along this creek, necessitating a much more dense sampling network than what was done, if the remedial plan is to simply cap only those areas where the samples taken showed high levels of contamination.

8. **Dredging is a more permanent solution than the cap/thin sand covering concepts**

These proposed remedial concepts do not permanently remove the contaminants from the area, and are subject to failure as discussed above. Dredging and removal of the contaminated sediments would be a permanent solution.

Section V. Opinions

The above review of information and findings support the following opinions:

- Chemicals of Concern have been and still are released in significant quantities into the Turtle River estuary system on a daily basis. The tidal action within the marsh area will ensure a constant exchange of sediment to and from the marsh area on a daily basis.
- The water quality in the Turtle River estuary system has continually deteriorated over the past several decades as a result of the contamination emanating from the Site. This will continue until the Site has been properly remediated.
- The location of the Site in direct proximity and connection to the Turtle River estuary system has created a major environmental impact on the immediate area as recognized by the EPA, ATSDR, GEPD, and other organizations.
- Sampling network used to delineate areas that need remediation is lacking in density and frequency. From figure 6-5 it is clear that approximately 50% of Purvis Creek has not been sampled for contaminants of concern. It is more likely than not that many of these non-sampled areas are contaminated with contaminants of concern.
- The proposed cap will probably fail for a number of reasons listed below:
    - Destruction of capping/cover material by scouring due to tidal action.

- Destruction of capping/cover material by hurricane type storms.
- Destruction of capping/cover material by changing hydraulic conditions due to sea-level rise.
- Destruction of capping/cover material by changing environmental conditions typically associated with meandering creeks within delta systems.
- Destruction of capping/cover material by sediment dwelling organisms.
- Lateral movement of contaminants within the subsurface sediment has not been addressed.

- Another major concern will be the long term monitoring that needs to take place after remediation has been implemented and action plans when remedial systems fail to protect the surrounding environment from the chemicals of concern. If the cap is constructed, it will have to be continually maintained and repaired, and this does not provide a permanent solution.

The comments, herein, are based on a preliminary review of available data to date and are subject to change. If additional information becomes available and is provided to me regarding this case, I will review it and provide supplementary opinions as appropriate.

Section VI. Documents Reviewed

1. *November 2014, U.S. Environmental Protection Agency Superfund Proposed Plan, LCP Chemicals Superfund Site, Operable Unit 1, City of Brunswick, Glynn County, Georgia*

2. *June 2, 2014 Draft Feasibility Study, Operable Unit No. 1 (Estuary), LCP Chemicals Superfund Site, Brunswick, Georgia (Draft)*

3. *June 20, 2013 Letter From Galo Jackson, USEPA to Prashant Guta, Honeywell, Subject: Comments on the Draft Feasibility Study Report for the Estuary, Operable Unit One*

4. *February 2013 Remedial Investigation Report Operable Unit 3 - Upland Soils, LCP Chemicals Site, Brunswick, Georgia (FINAL)*

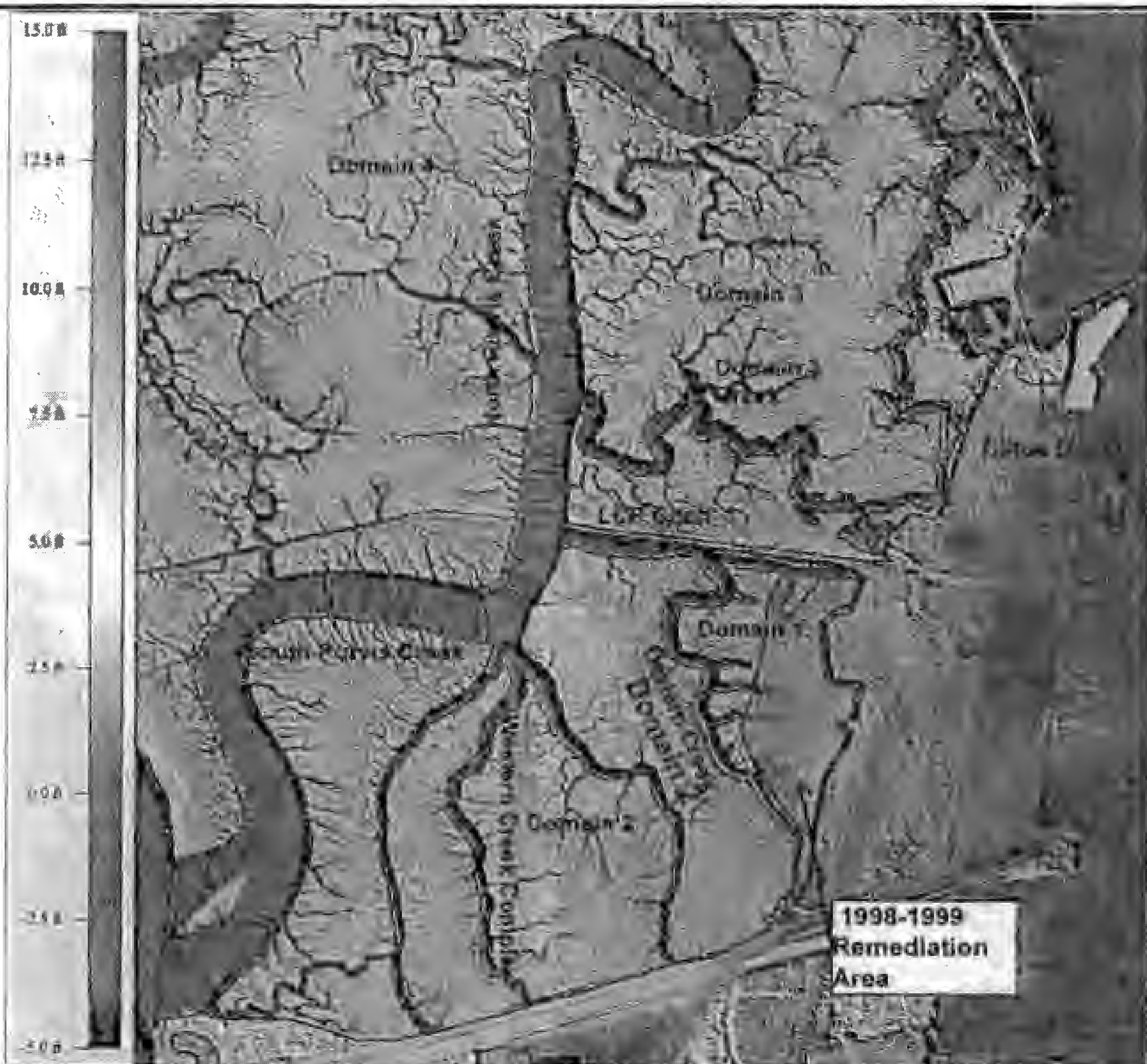
5. *October 2012 Remedial Investigation Report Operable Unit One - Estuary LCP Chemicals Site, Brunswick, Georgia (FINAL)*

ENVIRON
ANCHOR QEA

Site Location Map		Figure 2-1
LCP CHEMICAL SITE, BRUNSWICK, GEORGIA		

Turtle River/Brunswick Estuary	Figure 2-5
LCP CHEMICAL SITE, BRUNSWICK, GEORGIA	

Marsh Inundation – Mean High High Water	Figure 2-7
LCP CHEMICAL SITE, BRUNSWICK, GEORGIA	

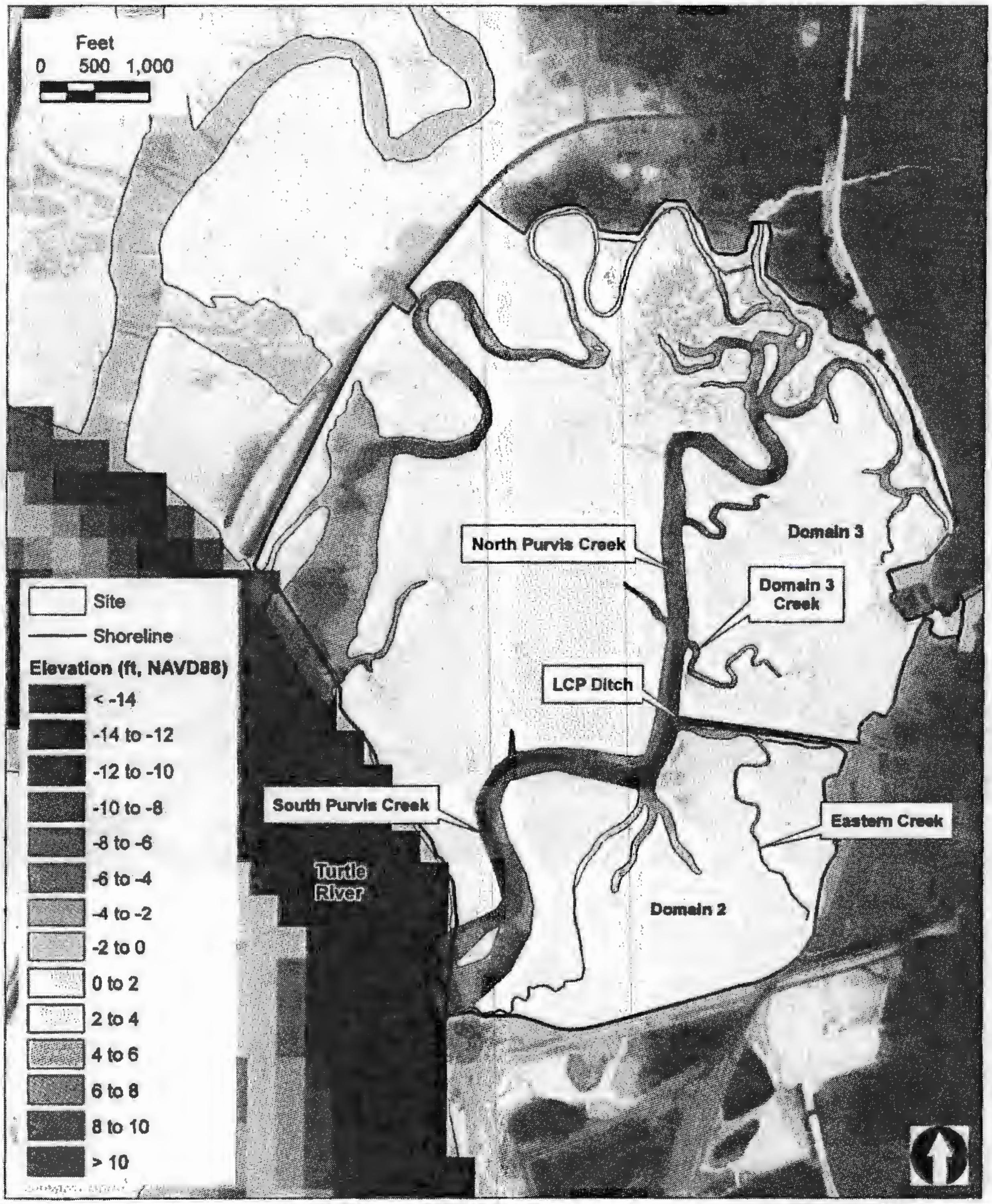


Marsh Inundation – Mean Low Low Water

LCP CHEMICAL SITE, BRUNSWICK, GEORGIA

Figure

2-8

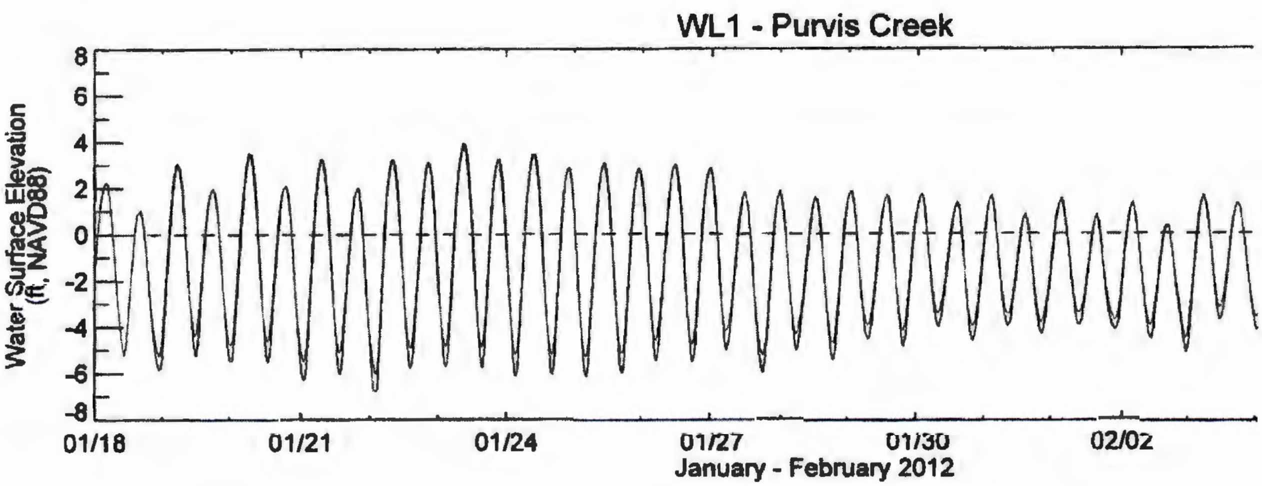


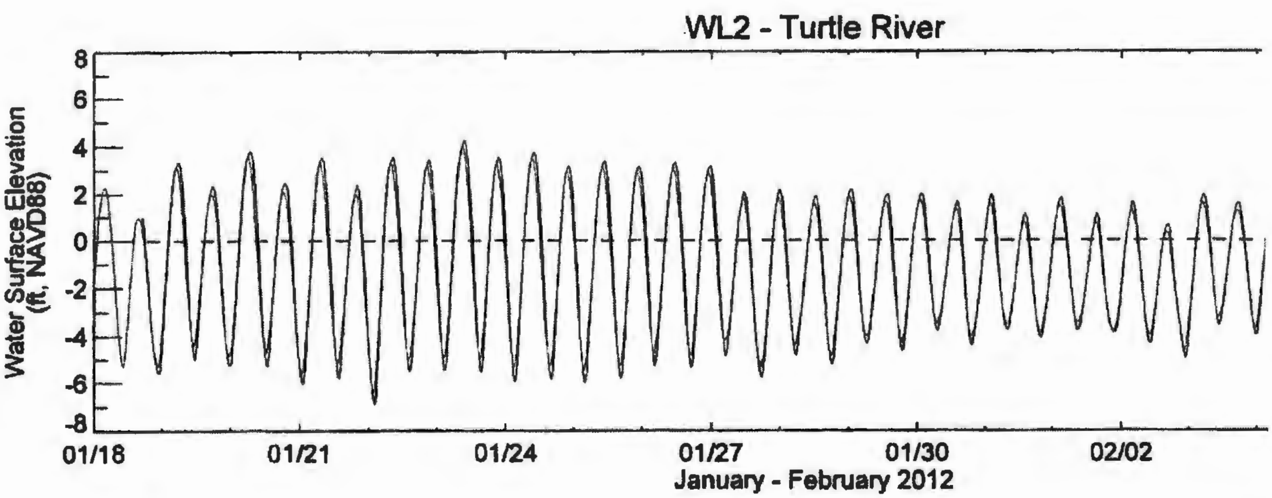
ENVIRON
ANCHOR QEA

Surface Elevation within the Site based on LiDAR Data in Marshes and Single-beam Bathymetry in Channels

LCP CHEMICAL SITE, BRUNSWICK, GEORGIA

Figure B2-4



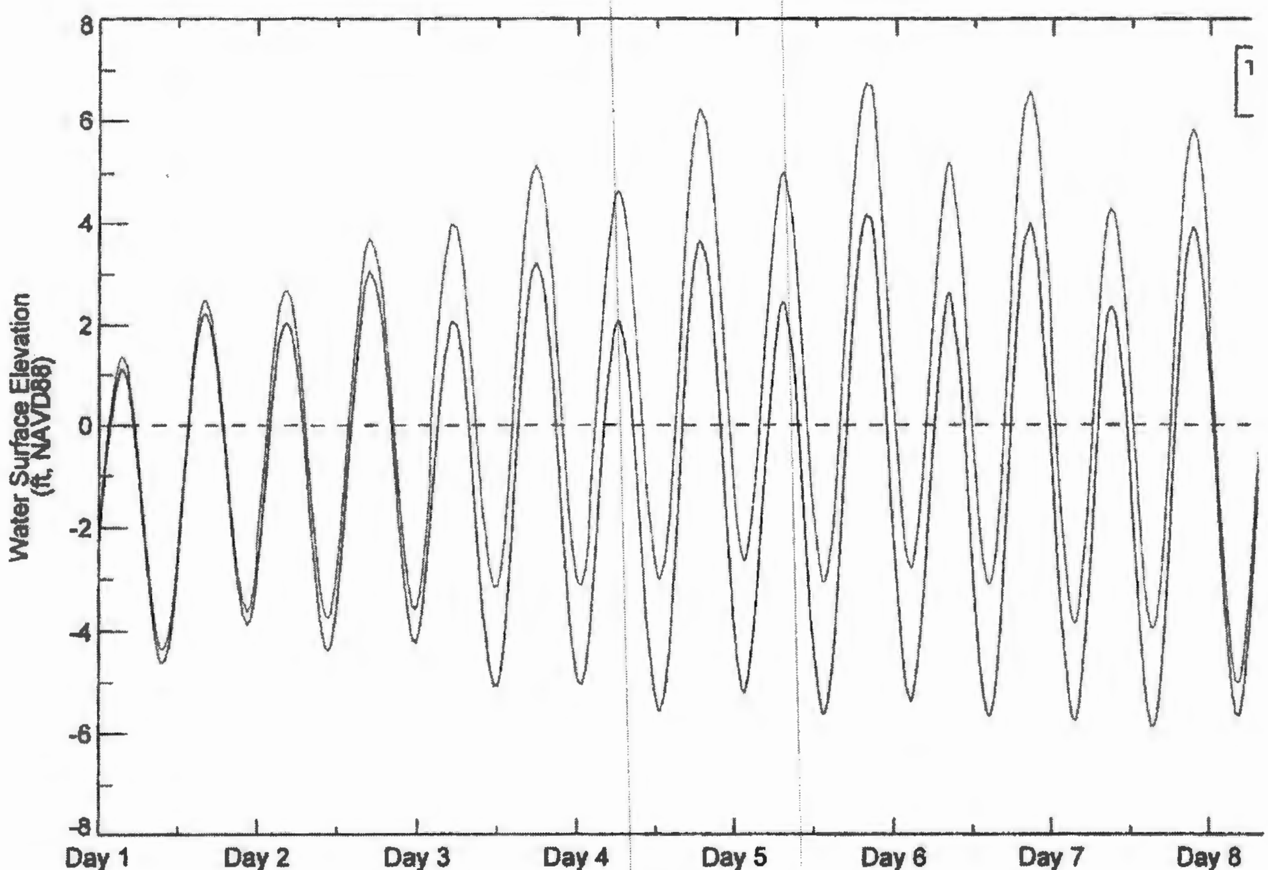


ENVIRON

ANCHOR QEA

Comparison of Predicted and Measured Water Surface Elevation at Stations WL1 and WL2

LCP CHEMICAL SITE, BRUNSWICK, GEORGIA

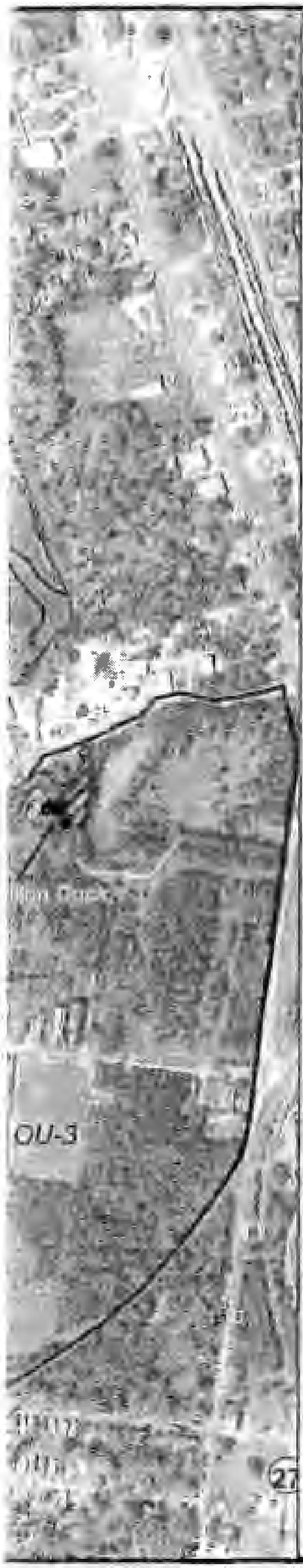


ENVIRON

ANCHOR QEA

Water Surface Elevation at Downstream Boundary during Hurricane Storm Surge Simulation

LCP CHEMICAL SITE, BRUNSWICK, GEORGIA



Legend

- Exceeds Benthic Community RGOs Shown Below
- No Exceedance of Benthic Community RGOs Shown Below
- Remediation Area (48 acres)
- Excluded Area (33 acres)
- OU1 Boundary
- Creek/Domain Boundary
- OU3 Boundary

Constituent	SWAC RGOs	Benthic Community RGOs
Hg	1	4
Ar1268	2	6
Pb	--	90
TPAHs	--	4

Notes:
- Units for all RGOs is mg/kg.

OU1 Boundary Source: Glynn County LiDAR Data, 2007.

ıent Management Area 1

ıICAL SITE, BRUNSWICK, GEORGIA

Figure 5-2

Spatial Distribution and Concentration of Aroclor-1268 in LCP Marsh Sediment

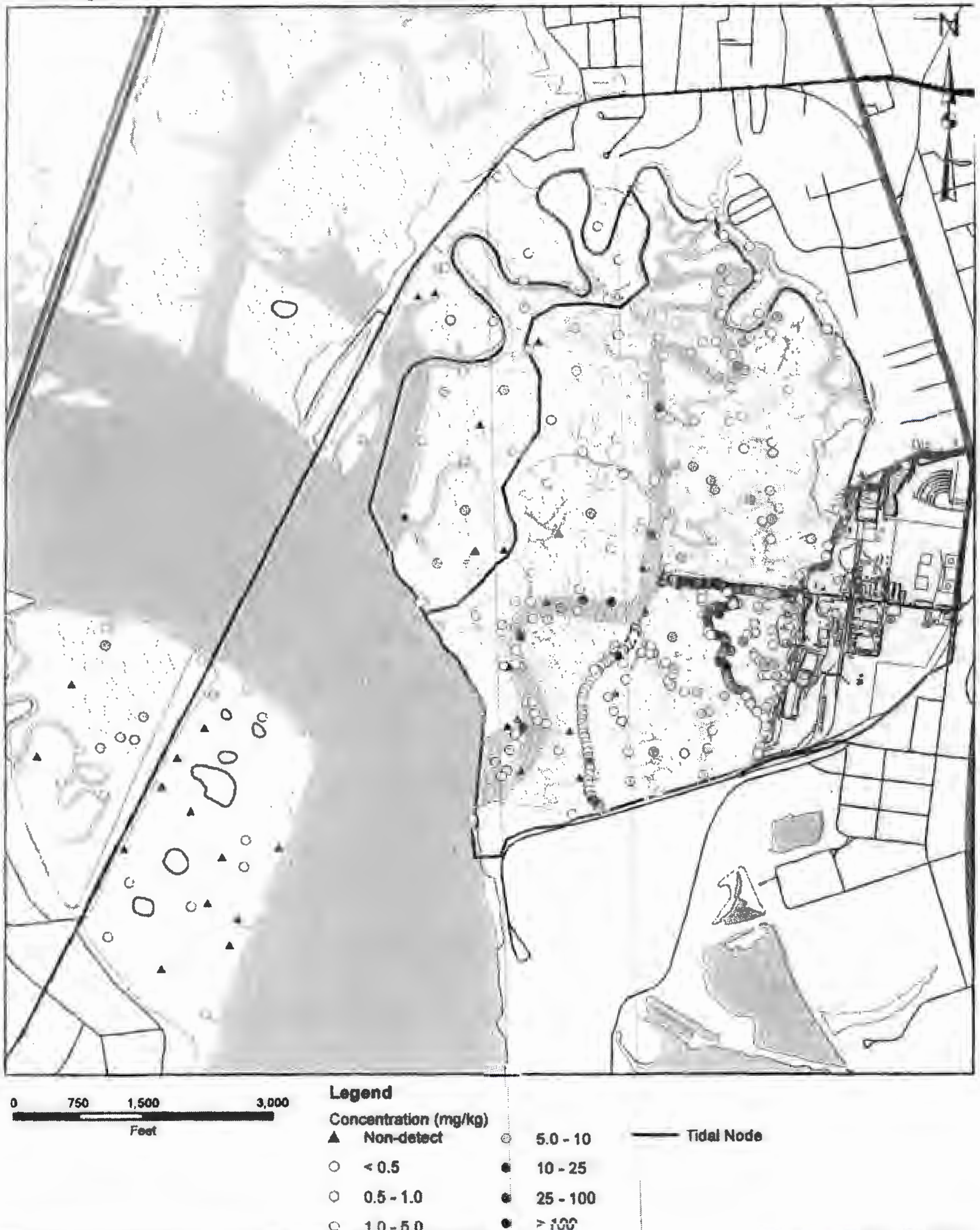


Figure 6-1C

Legend

- No Exceedance of Either Lower or Upper End Benthic RGOs
- Within the Range of Benthic Community RGOs
- Exceeds Range of Benthic Community RGOs
- No Sample Location in 50-Meter Averaging Polygon
- Does not Exceed the Range of the Benthic Community RGOs Shown Below
- Within the Range of the Benthic Community RGOs Shown Below
- Exceeds the Range of the Benthic Community RGOs Shown Below
- OU1 Boundary
- Creek/Domain Boundary
- OU3 Boundary

Constituent	SWAC RGOs	Benthic Community RGOs
Hg	1-2	4-11
Ar1268	2-4	6-16
Pb	--	90-177
TPAHs	--	4

Notes:
-Colored boxes in Purvis Creek and Western Creek Complex reflect locations where averaging along approximately 50-meter polygons was conducted when more than one sample was collected within the approximate 50-meter interval.
-Units for all RGOs is mg/kg.

N

0 800 1,600
Feet

OU1 Boundary Source: Glynn County LIDAR Data, 2007.

deration for Alternative 1

INSWICK, GEORGIA

Figure 6-5

February 2013

Philip B. Bedient, Ph.D., P.E.
Curriculum Vitae

ADDRESS:

Herman Brown Professor of Engineering
Department of Civil and Environmental Engineering
Rice University/MS - 317
6100 Main St. / Houston, Texas 77005
(713) 348-4953 or fax (713) 348-5239
Email – bedient@rice.edu

P.B. Bedient and Associates, Inc.
13910 Wilde Forest Court
Sugar Land, TX 77498
(281) 491-3911

EDUCATION:

Exemption 6 Personal Privacy

B.S. Physics, University of Florida, Gainesville, Florida, [redacted]
M.S. Environmental Engineering, University of Florida, [redacted]
Ph.D. Environmental Engineering Sciences, University of Florida, [redacted]

PROFESSIONAL EXPERIENCE:

Herman Brown Professor of Engineering - Civil and Environmental Engineering- Rice University - July 2001 to present.
Professor - Environmental Engineering - Rice University - 1986 to 2001.
Professor and Chair - Department of Environmental Science and Engineering, Rice University, Houston, Texas, 1992 - 1999.
Associate Professor - Environmental Engineering – 1980 - 1986.
Assistant Professor - Environmental Engineering – 1975 - 1980.

SCIENTIFIC SOCIETIES:

American Society of Civil Engineers
American Institute of Hydrology
American Water Resources Association
Association of Environmental Engineering Professors
American Academy of Water Resources Engineers
American Geophysical Union

HONORS:

Diplomate - Water Resources Engineer, American Academy of Water Resources Engineers (2008)
C.V. Theis Award from the American Institute of Hydrology (April 2007)
Fellow – American Society of Civil Engineers (April, 2006)
Endowed Chair – Herman Brown Professor in Engineering (July, 2001)
Shell Distinguished Chair in Environmental Science (1988-93)
Phi Beta Kappa

PROFESSIONAL COMMITTEES:

SSPEED Center Committee 2007-2012
Expert Panel – "Impacts of Climate Change on Transportation Systems and Infrastructure in the Gulf Coast" USDOT and USGS, 2005 - 2006
TS Allison Recovery Project - Technical Advisory Committee - 2002-2003
Harris County Flood Control District - Brays Bayou Federal Project Com – 1998- 2002

National Academy of Engineers (National Research Council)
Committee on DoE Environmental Management Technologies (CEMT) - 1995-96
Committee on In-Situ Bioremediation - 1992-93

UNIVERSITY COMMITTEES:

Undergraduate Curriculum Committee, 2005-2012
Accreditation (ABET/SACS) Committee, 2005-2012
Events and Reception Committee (Chair) 2012
Mentorship Committee 2012
Space Planning Committee, 2005-2012
CEE Student-Group Advisors 2012
BSCE Advisor 2012
Center for Civic Engagement Committee, 2007-2012
Parking Committee, 1998-2012
Search Committee, Civil and Environmental Engineering, (2001-2002)
Chair, Dean of Engineering Search Committee, (1988)
Computer Committee, Athletics Committee, 1998-2000
Advisory Council, School of Engineering.

LICENSES:

Professional Engineer, State of Texas, Environmental Engineering (45626)
Professional Hydrologist, American Institute of Hydrology

RESEARCH INTERESTS:

Floodplain Management - Analysis of effects of land use changes and development patterns on flood hydrographs and floodplain boundaries; use of lumped and distributed hydrologic models; detailed modeling of alternative flood control strategies and dynamic floodplain models. Analysis of the severe storm impacts in urban watershed areas using radar rainfall data, combined with GIS techniques for digital terrain and hydraulic modeling in Houston and other coastal areas in Texas.

Flood Alert Systems with Radar - The development of a real-time flood ALERT system (FAS) for Brays Bayou and the Texas Medical Center in Houston, TX has been completed. The FAS currently uses NEXRAD radar for application to flood prediction and real-time flood alert systems. FAS2 is a second-generation system being implemented with funding from FEMA after TS Allison. TXDOT funded a new FAS for inundated bridge crossings (2008).

Groundwater Contaminant Transport - Monitoring and modeling of groundwater hydrology and contaminant movement from various waste sources, numerical and analytical methods for transport with biodegradation. Development and application of tracer studies and models for groundwater transport with biodegradation in a controlled release tank (ECRS), for studying degradation of PCE and TCE plumes and for ethanol in fuel spills. Analysis of plume dynamics at sites in California, Texas and Florida.

Hazardous Waste Site Evaluation - Monitoring and modeling of waste plumes associated with 35 hazardous waste sites nationally. Identification of extent of contamination, transport mechanisms, and control strategies. MODFLOW and RT3D modeling of transport and aquifer restoration using withdrawal-treatment and microbial degradation methods. Analysis of hazardous waste sites in California, Texas and Florida.

COURSES and STUDENTS:

- CEVE 412 - Hydrology and Watershed Analysis
- CEVE 512 - Hydrologic Design Laboratory

- CEVE 101 - Fundamentals of Civil and Environmental Engineering
- CEVE 415/515 - Water Resources Planning and Management (50%)

- 13 Ph.D. and 59 M.S. degrees since 1975

RESEARCH STATEMENT:

Dr. Philip B. Bedient is also Herman Brown Professor of Engineering in the Dept of Civil and Environmental Engineering at Rice University. He teaches and performs research in surface and ground water hydrology, disaster management, and flood prediction systems. He served as Chair of Environmental Engineering from 1992 to 1999. He has directed 60 research projects over the past 38 years, worth of $15 million in research, and has written over 180 articles in journals and conference proceedings. He is lead author on a text on "Hydrology and Floodplain Analysis" (Prentice Hall, 5th ed., 2012) used in over 75 universities across the U.S. He also has a second text on "Groundwater Contamination: Transport and Remediation" (Prentice Hall, 2nd ed., 1999). Dr. Bedient received the Herman Brown endowed Chair of Engineering in 2002 at Rice University. He was elected to Fellow ASCE in 2006 and received the prestigious C.V. Theis Award (groundwater) from the American Institute of Hydrology in 2007. He earlier received the Shell Distinguished Chair in Environmental Science (1988 to 1993) for his work on biodegradation modeling of fuel spills.

He has worked groundwater problems for over 38 years including over 30 major hazardous waste sites and four military bases in Texas, Florida, Utah, Michigan, California, and Louisiana. He has been actively involved in the area of hydrologic transport and groundwater remediation, and developed the original EPA Bioplume Model used for many years to evaluate BTEX plume behavior. He was PI on the Hill Air Force Base Advanced Remediation Study of DNAPL contamination from 1994 – 1999.

He is the current director of the Severe Storm Prediction Center (SSPEED) at Rice University (since 2007) consisting of a team of seven universities and 15 investigators from Gulf coast universities dedicated to improving storm prediction, education, and evacuation from disaster. The Center was approved by the Texas Legislature and is currently funded at over $4.5 million for 5 years from various sources including the Houston Endowment (Hurricane Ike Lessons Learned and Future Steps). A book has been developed and published by TAMU press titled "Lessons from Hurricane Ike" published in June 2012.

Dr. Bedient has over 37 years of experience working on flood and flood prediction problems in the U.S. He has evaluated flood issues in Texas, California, Florida, Louisiana, and Tennessee. He has worked on some of the largest and most devastating floods to hit the U.S. including the San Jacinto River flood of 1994, T.S. Frances in 1998, T.S. Allison in 2001, Hurricane Katrina in 2005, Hurricane Rita in 2005, Hurricane Ike in 2008, and the Nashville, TN flood of 2010. He routinely runs computer models such as HEC-HMS, HEC-RAS, SWMM, and VFLO for advanced hydrologic analysis. He developed one of the first radar based rainfall flood alert systems (FAS-3) in the U.S. for the Texas Medical Center.

The SSPEED Center has put on a number of conferences, meetings, and training courses since 2007. Prominent national speakers have been invited to these conferences, which include attendees from academia, industry, consulting, and emergency managers. These conferences provide a forum for public discussion and response for decision and policy makers, and stakeholders. As a result of this work, we have received a large number of Rice News stories over the past several years, in the form of both video interviews with the media as well as newspaper coverage.

Dr. Bedient has been involved in the technology transfer area for more than three decades through the teaching of short courses for government, university, and private sectors in both groundwater contamination and surface water modeling and prediction.

SURFACE WATER PROJECT

"SSPEED Center Proposal to the Houston Endowment Coastal Integrated Program", Houston Endowment, 2011-2014, $3,200,000.

"FAS3- Operational Support", Texas Medical Center, 2012, $69,000

"Urban Resilience: Flooding in the Houston-Galveston Area", Kinder. 2009-2012, $24,003

"White Oak Bayou BMP Demonstration Project – Cottage Grove Subdivision", City of Houston, 2009-2013, $165,000.

"Rice University FEMA: Food Analysis", Rice, 2011-2012, $70,000

"Amendment to Expand Development and Validation of the Online Storm Risk Calculator Tool for Public Usage", City of Houston, 2011, $388,030

"Hurricane Ike: Lessons Learned and Steps to the Future", Houston Endowment, 2009-2012, $1,250,000

"Libya AEL Training Grant", AECOM, 2008-2010, $1.7 million over 2 years.

"Texas OEM SSPEED Training" University of Texas, 2008, $90,000

"Watershed Information Sensing and Evaluation System", Houston Endowment (with UH), 2007-2010, $400,000.

"Advanced Flood Alert System for the TXDOT for Bridge Control at 288", HGAC, 2007-2011 $200,000.

"Civil and Environmental Engineering for the 21st Century", NSF Dept Reform Grant, 2005-2007, $100,000.

"CASA – Collaborative Adaptive Sensing of the Atmosphere – the Houston Testbed", NSF, 2003 – 2009, $110,000, ($90,000 for 2006-07).

"FAS2 - Operational Support", Texas Medical Center, 2003-2012, $69,000

"Flood Alert System (FAS2) for the Texas Medical Center and Brays Bayou", FEMA, 2002-2003, $300,000.

"Multi-Purpose Water Management Technology for the Texas Mexico Border", Advanced Technology Program, 2000-2001, $129,000.

"Analysis of Clear Creek Watershed," Galveston Bay Preservation Foundation, 1999-2000, $15,000.

"Flood Alert System - Maintenance and Support", Texas Medical Center, 1998-2002, $271,000.

"Flood Prediction System for the Texas Medical Center", Texas Medical Center, 1997-1998, $262,000.

"The Effects of Changing Water Quality and Market Inefficiencies on Water Resource Allocation in the Lower Rio Grande Valley", Energy and Environmental Systems Institute, Rice University, 1996-1997, $12,000.

"Characterization of Laguna Madre Contaminated Sediments", Environmental Protection Agency, 1995, $68,500.

"Role of Particles in Mobilizing Hazardous Chemicals in Urban Runoff", Environmental Protection Agency, 1992-95, $240,000. (P. B. Bedient, Co-P.I.).

"Galveston Bay Characterization Report", Galveston Bay National Estuary Program, 1991-1992, $35,000.

"Characterization of Non-Point Sources and Loadings to Galveston Bay", Galveston Bay National Estuary Program, 1990-1991, $125,000.

"Linkages between Sewage Treatment Plant Discharges, Lake Houston Water Quality, and Potable Water Supply during Storm Events", City of Houston, 1984-1985, $42,200.

"Plan of Study for Upper Watershed Drainage Improvements and Flood Control - San Jacinto River Basin", subcontract from R. Wayne Smith, Engineer, 1984-85, $120,260.

"Harris Gully Sub watershed Study", South Main Center Association, 1983-1984. $15,000.

"Sedimentation and Nonpoint Source Study of Lake Houston", Houston-Galveston Area Council, 1981-1982, $55,000.

"Environmental Study of the Lake Houston Watershed - Phase II", Houston-Galveston Area Council, 1980-1981, $30,000.

"Evaluation of Effects of Storm water Detention in Urban Areas", matching grant with City of Houston Health Department, Office of Water Research and Technology (OWRT), Washington, D.C., and City of Houston Public Health Engineering, 1980-81, $116,000.

"Environmental Management of the Lake Houston Watershed", Funded by City of Houston, Dept. of Public Health, 1978-80, $80,000.

"A Preliminary Feasibility Report for Bear Creek, Texas, Local Protection Project", Grant to Southwest Center for Urban Research, Funded by U.S. Army Corps of Engineers, 1977-78, $47,000.

"Environmental Study of New Iberia Navigation Port and Channel, Louisiana", Funded to Rice Center, 1979, $50,000.

"Strategies for Flood Control on Cypress Creek, Texas", Funded by U.S. Corps of Engineers, Galveston, Texas, 1977, $9,500.

"Water Quality Automatic Monitoring and Data Management Information System", Funded by City of Houston, Dept. of Public Health, 1977-1978, $62,414.

"Maximum Utilization of Water Resources in a Planned Community", The Woodlands Project, 1975-1976.

GROUNDWATER PROJECTS

"A Large-Scale Experimental Investigation of the Impact of Ethanol on Groundwater Contamination", (P.J.J. Alvarez – Co-P.I.) American Petroleum Institute, 2004-2007, $120,000.

"A Large-Scale Experimental Investigation of the Impact of Ethanol on Groundwater Contamination", Gulf Coast Hazardous Substances Research Center, 2004-2005, $45,000.

"A Large-Scale Experimental Investigation of the Impact of Ethanol on Groundwater Contamination", Gulf Coast Hazardous Substances Research Center, 2003-2004, $95,000.

"Chlorinated Solvent Impact and Remediation strategies in the Dry Cleaning Industry", Gulf Coast Hazardous Substances Research Center, 2000 – 2003, $149,400.

"Design Manual for the Extraction of Contaminants from Subsurface Environments", Environmental Protection Agency, 1994-2002, $4,500,000.

"Development of Data Evaluation/Decision Support System for Bioremediation of Subsurface Contamination", Environmental Protection Agency, 1993-1996, $450,000.

Shell Distinguished Chair in Environmental Science, Shell Oil Company Foundation, 1988-1993, $750,000.

"Evaluation of Nitrate-Based Bioremediation: Eglin Air Force Base", Environmental Protection Agency, 1992-1993, $120,000.

"Decision Support System for Evaluating Remediation Performance with Interactive Pump-and-Treat Simulator", Environmental Protection Agency, 1992-1994, $250,000.

"Characterization of Oil and Gas Waste Disposal Practices and Assessment of Treatment Costs", Department of Energy, 1992-94, $200,000.

"Subsurface Monitoring Data for Assessing In-Situ Biodegradation of Aromatic Hydrocarbons (BTEX) in Groundwater", American Petroleum Institute, 1991-93, $170,000.

"System 9 GIS System", Prime Computers, 1989-90, $50,000.

"Effects of Various Pumping and Injection Schemes and Variable Source Loading on Biorestoration", American Petroleum Institute, 1988-90, $186,000.

"Parameter Estimation System for Aquifer Restoration Model", U.S. Environmental Protection Agency, 1987-89, $400,000.

"Distribution of BIOPLUME II", National Center for Ground Water Research (EPA), 1987-88, $40,000.

"Development and Application of a Groundwater Modeling Data Base for Hazardous Waste Regulation", American Petroleum Institute, 1987-88, $40,000.

"Practical Procedures for Evaluating Attenuation of Ground Water Contaminants Due to Biotransformation Process", National Center for Ground Water Research (EPA), 1986-87, $150,000.

"Modeling and Field Testing of Contaminant Transport with Biodegradation and Enhanced In Situ Biochemical Reclamation", National Center for Ground Water Research (EPA), 1985-88, $249,000.

"Ground Water Modeling for the Houston Water Plant", City of Houston, subcontract from Law Engineering & Testing Co., 1985-86, $127,000.

"Environmental Fate and Attenuation of Gasoline Components in the Subsurface", American Petroleum Institute, 1984-86, $78,300.

"Simulation of Contaminant Transport Influenced by Oxygen Limited Biodegradation", National Center for Ground Water Research (EPA), 1984-85, $25,500.

"Ground Water Pollutant Transport along Flow Lines for Hazardous Waste Sites", National Center for Ground Water Research (EPA), 1983-85, $167,000.

"Math Models for Transport and Transformation of Chemical Substances in the Subsurface", National Center for Ground Water Research (EPA), Subcontract from Oklahoma State University, 1982-83, $15,000.

"Characterization of Ground Water Contamination from Hazardous Waste Sites", National Center for Ground Water Research (EPA), 1982-83, $113,000.

"Characterization of Ground Water Contamination from Hazardous Waste Sites", National Center for Ground Water Research (EPA), 1980-82, $45,000.

PUBLICATIONS AND PRESENTATIONS

A. Books or Related Chapters

1. Bedient, P. B. and W. C. Huber, 2012, "Hydrology and Floodplain Analysis", 5th Ed. Prentice-Hall Publishing Co., Upper Saddle River, NJ, February, 2012, 800 page textbook.

2. Bedient, P. B. and J. Blackburn, 2012 "Lessons learned from Hurricane Ike" Ed. Philip Bedient. College Station, TX: Texas A&M University Press, College Station, TX: 2012, 194 Pages

3. Rifai H.S., Borden R.C., Newell C.J. and Bedient P.B., " Modeling Remediation of Chlorinated solvent plumes" In Situ Remediation of Chlorinated solvent Plumes, Chapter 6, H.F. Stroo, C.H. Ward Editors, Springer, N.Y. 2010, 145 pp.

4. Bedient, P. B., Rifai H. S., and Newell C. J., "Ground Water Contamination: Transport and Remediation", 2nd Ed. PTR Publ., Upper Saddle River, NJ, 1999, 605 pages.

5. Thompson, J.F. and Bedient, P.B. "Urban Storm Water Design and Management," The Engineering Handbook, Chapter 94, CRC Press, 2004, 21 pp.

6. Fang, Z., Safiolea, E., Bedient, P.B. (2006) "Enhanced Flood Alert and Control Systems for Houston." In Chapter 16, Coastal Hydrology and Processes, Ed. By Vijay P. Singh and Y. Jun Xu, Water Resource Publications, LLC, pp. 199-210

7. Capiro, N.L. and Bedient P.B. "Transport of Reactive Solute in Soil and Groundwater" The Water Encyclopedia (2005): 524-531.

8. Horsak, R.D., Bedient, P.B., Thomas, F.B., and Hamilton, C. "Pesticides", Environmental Forensics (2005).

9. Charbeneau, R. J., Bedient, P. B. and Loehr R. C., "Groundwater Remediation", Technomic

Publishing Co., Inc., Lancaster, PA 1992, 188 pages.

B.Peer Reviewed Journal Publications

1. Teague, A., J. Christian, and P. Bedient. (2013) "Use of Radar Rainfall in an Application of Distributed Hydrologic Modeling for Cypress Creek Watershed, Texas". Journal of Hydrologic Engineering. DOI: 10.1061/(ASCE)HE.1943-5584.0000567 American Society of Civil Engineers.
2. Doubleday, G., Sebastian A., Luttenschlager, T., and Bedient, B. (2013) Modeling Hydrologic Benefits of Low Impact Development: A Distributed Hydrologic Model of The Woodlands, Texas, Journal of American Water Resources Association
3. Christian, J., A. Teague, L. Duenas-Osario, Z. Fang, and P. Bedient, (2012). "Uncertainty in Floodplain Delineation: Expression of Flood Hazard and Risk in a Gulf Coastal Watershed." Journal of Hydrological Processes, doi:10.1002/hyp.9360.
4. Ray, T., Stepinski, E., Sebastian, A., Bedient, P.B. (2011)"Dynamic Modeling of Storm Surge and Inland Flooding in Texas Coastal Floodplain" ", Journal of Hydrologic Engineering, ASCE, Vol. 137, No.10, October 2011, ISSN 0733-9429/2011/10-1103-1110
5. Fang, Z., Bedient, P. B., and Buzcu-Guven, B. (2011). "Long-Term Performance of a Flood Alert System and Upgrade to FAS3: A Houston Texas Case Study". Journal of Hydrologic Engineering, ASCE Vol. 16, No. 10, October 1, 2011, ISSN 1084-0699/2011/10-818-828.
6. Stepinski, E., J. Christian, and P. Bedient, (2011.) "Methods for Modeling Coastal Floodplains Under Hurricane Storm Surge Conditions." Journal of Hydrological Processes. (Accepted) July 2011
7. Teague, A., Bedient, P. and Guven, B. (2010). "Targeted Application of Seasonal Load Duration Curves using Multivariate Analysis in Two Watersheds Flowing into Lake Houston" (JAWRA-10-0003-P.R1). Journal of American Water Resources Association. Accepted.
8. Fang, Z, Zimmer, A., Bedient, P. B, Robinson, H., Christian, J., and Vieux, B. E. (2010). "Using a Distributed Hydrologic Model to Evaluate the Location of Urban Development and Flood Control Storage". Journal of Water Resources Planning and Management, ASCE, Vol. 136, No. 5, September 2010, ISSN 0733-9496/2010/5-597-601.
9. Fang, Z., Bedient, P. B., Benavides J.A, and Zimmer A. L. (2008). "Enhanced Radar-based Flood Alert System and Floodplain Map Library". Journal of Hydrologic Engineering, ASCE, Vol. 13, No. 10, October 1, 2008, ISSN 1084-0699/2008/10-926-938.
10. Gomez, D. E., De Blanc, P. C., Rixey, W., Bedient, P.B., Alvarez, P. J.J. (2008), "Evaluation of Benzene Plume Elongation Mechanisms Exerted by Ethanol Using RT3D with a General Substrate Interaction Module" Water Resource Research Journal, Vol. 44, May.
11. Rifai, H.S., Borden, R. C., Newell, C. J., and Bedient, P.B. "Modeling Dissolved Chlorinated Solvents in Groundwater and Their Remediation," in SERDP monograph on Remediation of Dissolved Phase Chlorinated Solvents in Groundwater, (accepted) 2007.
12. Bedient, P. B., Holder, A., and Thompson, J. F., and Fang, Z. (2007). "Modeling of Storm water Response under Large Tailwater Conditions – Case Study for the Texas Medical Center". Journal of Hydrologic Engineering, Vol. 12, No. 3, May 1, 2007.
13. Capiro, N.L., Stafford, B.P., Rixey, W.G., Alvarez, P.J.J. and Bedient, P.B. "Fuel-Grade Ethanol Transport at the Water Table Interface in a Pilot-Scale Experimental Tank" Water Research, 41(3), pp. 656-654, 2007.

14. Bedient, P.B., Rifai, H.S., Suarez, M.P., and Hovinga, R.M. "Houston Water Issues" Chapter in Water for Texas. Jim Norwine and J.R. Giardino, Eds. pp. 107-121, 2005.

15. Characklis, G.W., Griffin, R.C., and Bedient, P.B. "Measuring Long-term Benefits of Salinity Reduction" Journal of Agricultural and Resource Economics, 30 (1) (2005): 69-93.

16. Bedient, P.B., Horsak, R.D., Schlenk, D., Hovinga, R.M., and Pierson, J.D. "Environmental Impact on Fipronil to Louisiana Crawfish Industry" Environmental Forensics (2005): 289-299.

17. Characklis, G. W., Griffin, R.C., and Bedient, P.B. "Measuring the Long-term Benefits of Salinity Reduction" Journal of Agricultural and Resource Economics, 30(1), pp.69-93, 2005.

18. Vieux, B.E. and Bedient, P.B. "Assessing urban hydrologic prediction accuracy through event reconstruction" Journal of Hydrology, 299(3-4), pp. 217-236. Special Issue on Urban Hydrology, 2004.

19. Thompson, J.F. and Bedient, P.B. "Urban Storm Water Design and Management" The Engineering Handbook, Chapter 94, CRC Press, 2004, 21 pp.

20. Capiro, N.L. and Bedient P.B. "Transport of Reactive Solute in Soil and Groundwater" The Encyclopedia of Water, John Wiley and Sons, Inc., New York, NY, USA pp. 524-531, 2005.

21. Bedient, P.B., Holder, A., and Benavides, J. "Advanced Analysis of T.S. Allison's Impacts" submitted to Jn. of American Water Resources Assn., 2004.

22. Bedient, P. B., A. Holder, J. Benavides, and B. Vieux "Radar-Based Flood Warning System applied to TS Allison, ASCE Journal of Hydrologic Engineering, 8(6), pp 308-318, Nov, 2003.

23. Glenn, S., Bedient, P.B., and B. Vieux "Ground Water Recharge Analysis Using NEXRAD in a GIS Framework" submitted to Ground Water, October 2002.

24. Bedient, P.B., Vieux, B.E., Vieux, J.E., Koehler, E.R., and H.L. Rietz "Mitigating Flood Impacts of Tropical Storm Allison" accepted by Bulletin of American Meteorological Society, 2002.

25. El-Beshry, M., Gierke, J.S., and P.B. Bedient "Practical Modeling of SVE Performance at a Jet-Fuel Spill Site" ASCE Journal of Environmental Engineering pp. 630-638, (127) 7, July 2001.

26. El-Beshry, M.Z., Gierke, J.S., and P.B. Bedient "Modeling the Performance of an SVE Field Test" in Chapter 7, Vadose Zone Science and Technology Solutions, Brian B. Looney and Ronald W. Falta, editors, Vol. II, pp. 1157-1169, (2000).

27. Rifai, H.S., Brock, S.M. Ensor, K.B., and P.B. Bedient "Determination of Low-Flow Characteristics for Texas Streams" ASCE Journal of Water Resources Planning and Management, (126)5, pp.310-319, September-October 2000.

28. Bedient, P.B., Hoblit, B.C., Gladwell, D.C., and B.E. Vieux "NEXRAD Radar for Flood Prediction in Houston" ASCE Journal of Hydrologic Engineering, 5(3), pp. 269-277, July 2000.

29. Hamed, M.M., Nelson, P.D., and P.B. Bedient "A Distributed Site Model for Non-equilibrium Dissolution of Multicomponent Residually Trapped NAPL" Environmental Modeling and Software, (15), pp. 443-450, September 2000.

30. Holder, A.W., Bedient, P.B., and C.N. Dawson "FLOTRAN, a Three-dimensional Ground Water Model, with Comparisons to Analytical Solutions and Other Models" Advances in Water Resources, pp. 517-530, 2000.

31. Rifai, H.S., Bedient, P.B., and G.L. Shorr "Monitoring Hazardous Waste Sites: Characterization and Remediation Considerations" Journal of Environmental Monitoring, 2(3), pp. 199-212, June 2000.

32. Hoblit, B.C., Baxter, E.V., Holder, A.W., and P.B. Bedient "Predicting With Precision" ASCE Civil Engineering Magazine, 69(11), pp. 40-43, November 1999.

33. Bedient, P.B., Holder, A.W., Enfield, C.G., and A.L. Wood "Enhanced Remediation

Demonstrations at Hill Air Force Base: Introduction" Innovative Subsurface Remediation: Field Testing of Physical, Chemical, and Characterization Technologies, Mark L. Brusseau, et al., eds., pp. 36-48, American Chemical Society, Washington, DC, 1999.

34. Holder, A.W., Bedient, P.B., and J.B. Hughes "Modeling the Impact of Oxygen Reaeration on Natural Attenuation" Bioremediation Journal, 3(2): 137-149, June 1999.

35. Characklis, G.W., Griffin, R.C., and P.B. Bedient "Improving the Ability of a Water Market to Efficiently Manage Drought" Water Resources Research, (35)3, 823-831, March 1999.

36. Vieux, B.E. and P.B. Bedient "Estimation of Rainfall for Flood Prediction from WSR-88D Reflectivity: A Case Study, 17-18 October 1994" Weather and Forecasting, 1998 American Meteorological Society, 13:2, 407-415, June 1998.

37. Bedient, P.B. "Hydrology and Transport Processes" Subsurface Restoration, C.H. Ward, J.A. Cherry and M.R. Scalf, editors, Ann Arbor Press, Chelsea, MI, 59-73, 1997.

38. Hamed, M.M. and P.B. Bedient "On the Performance of Computational Methods for the Assessment of Risk from Ground-Water Contamination" Ground Water, 35(4), 638-646, July-August 1997.

39. Hamed, M.M. and P.B. Bedient "On the Effect of Probability Distributions of Input Variables in Public Health Risk Assessment" Risk Analysis, 17(1), 97-105, 1997.

40. Hamed, M.M., Bedient, P.B., and J.P. Conte "Numerical Stochastic Analysis of Groundwater Contaminant Transport and Plume Containment" Journal of Contaminant Hydrology, 1996, 24 pp.

41. Hamed, M.M., Bedient, P.B., and C.N. Dawson "Probabilistic Modeling of Aquifer Heterogeneity Using Reliability Methods" Advances in Water Resources, 19(5), 277-295, 1996.

42. Sweed, H., Bedient, P.B., and S.R. Hutchins "Surface Application System for In-Situ Bioremediation: Site Characterization and Modeling" Groundwater Journal, 34(2), 211-222, 1996.

43. Hamed, M.M., Conte, J.P., and P.B. Bedient "Uncertainty Analysis of Subsurface Transport of Reactive Solute Using Reliability Methods" Groundwater Models for Resources Analysis and Management, CRC Press, Inc., Chapter 8:123-135 1995.

44. Hamed, M.M., Conte, J.P., and P.B. Bedient "Probabilistic Screening Tool for Groundwater Contamination Assessment" ASCE Journal of Environmental Engineering, 121(11): 767-775, (1995).

45. Rifai, H.S. and P.B. Bedient "A Review of Biodegradation Models: Theory and Applications" Groundwater Models for Resources Analysis and Management, CRC Press, Inc., Chapter 16:295-312 (1995).

46. Rifai, H. S., Newell, C. J., Bedient, P.B., Shipley, F.S., and R.W. McFarlane, The State of the Bay, The Galveston Bay National Estuary Program, Webster, TX, 232 pp. (1994).

47. Rifai, H.S. and P.B. Bedient "Modeling Contaminant Transport and Biodegradation in Ground Water" Advances in Environmental Science Groundwater Contamination, Volume I: Methodology and Modeling, Springer-Verlag, New York, NY (1994).

48. Bedient, P.B. and H.S. Rifai "Modeling in Situ Bioremediation" In Situ Bioremediation, When Does It Work?" National Academy Press, pp. 153-159 (1993).

49. Rifai, H. S., Bedient, P.B., Hendricks, L.A., and K. Kilborn "A Geographical Information System (GIS) User Interface for Delineating Wellhead Protection" Ground Water, 31:3, pp. 480-488 (1993).

50. H. S. Rifai, Newell, C. J., and P.B. Bedient "Getting to the Nonpoint Source with GIS" Civil Engineering, June, pp. 44-46 (1993).

51. H. S. Rifai, Newell, C. J., and P.B. Bedient "GIS Enhances Water Quality Modeling" GIS World, August, pp. 52-55 (1993).

52. Bedient, P.B., Schwartz, F.W., and H.S. Rifai "Hydrologic Design for Groundwater Pollution Control" Handbook of Hydrology, McGraw Hill, pp. 29.1-29.47 (1993).

53. Wise, W.R., Robinson, G.C., and P.B. Bedient "Chromatographic Evidence for Nonlinear Partitioning of Aromatic Compounds Between Petroleum and Water" Ground Water, 30(6): 936-944. (Nov. - Dec. 1992).

54. Charbeneau, R.J., Bedient, P.B., and R.C. Loehr, Groundwater Remediation, Technomic Publishing Co., Inc., Lancaster, PA, 188 pages (1992).

55. Bedient, P.B. and H.S. Rifai "Ground Water Contaminant Modeling for Bioremediation: A Review" Journal of Hazardous Materials, 32:225-243 (1992).

56. Kilborn, K., Rifai, H.S., and P. B. Bedient "Connecting Groundwater Models and GIS" Geo Info Systems, pp. 26-31, (February 1992).

57. Rifai, H. S. and P. B. Bedient "Modeling Contaminant Transport and Biodegradation in Ground Water" To be published in Textbook: Advances in Environmental Science Groundwater Contamination, Volume I: Methodology and Modeling, Springer Verlag, (In Press) (September 1991).

58. Newell, C.J., Rifai, H.S., and P.B. Bedient "Characterization of Non-Point Sources and Loadings to Galveston Bay" Galveston Bay National Estuary Program, Houston, Texas, 150 pp (October 1991).

59. Rifai, H.S., Long, G.P., and P.B. Bedient "Modeling Bioremediation: Theory and Field Application" In Situ Bioreclamation Applications and Investigations for Hydrocarbon and Contaminated Site Remediation, Ed. by R. E. Hinchee and R. F. Olfenbuttel, Battelle Memorial Institute, Butterworth-Heinemann, Boston, (1991).

60. Kilborn, K., Rifai, H.S., and P.B. Bedient "The Integration of Ground Water Models with Geographic Information Systems (GIS)" 1991 ACSM/ASPRS 10 Annual Convention, Baltimore, Maryland, In Technical Papers, vol. 2, pp. 150-159, (March 1991).

61. Wise, W.R., Chang, C.C., Klopp, R.A., and P. B. Bedient "Impact of Recharge Through Residual Oil Upon Sampling of Underlying Ground Water" Ground Water Monitoring Review, pp. 93-100 (Spring 1991).

62. Rifai, H.S. and P.B. Bedient "Comparison of Biodegradation Kinetics with an Instantaneous Reaction Model for Ground Water" Water Resource. Res. 26:637-645 (1990).

63. Newell, C.J., Hopkins, L.P., and P.B. Bedient "A Hydrogeologic Database for Ground Water Modeling" Ground Water 28:703-714 (1990).

64. Newell, C.J., Haasbeek, J.F., and P.B. Bedient "OASIS: A Graphical Decision Support System for Ground Water Contaminant Modeling" Ground Water 28:224-234 (1990).

65. Chiang, C.Y., Wheeler, M.F., and P.B. Bedient "A Modified Method of Characteristics Technique and Mixed Finite Elements Method for Simulation of Ground Water Contaminant Transport" Water Resource. Res. 25:1541-1549 (1989).

66. Todd, D.A., Bedient, P.B., Haasbeek, J.F., and J. Noell "Impact of Land Use and NPS Loads on Lake Water Quality" ASCE J. Environmental Engr. Div. 115:633-649 (1989).

67. Borden, R.C., Lee, M.D., Thomas, J.M., Bedient, P.B., and C.H. Ward "In Situ Measurement and Numerical Simulation of Oxygen Limited Biotransformation" Ground Water Monit. Rev. 9:83-91 (1989).

68. Rifai, H.S., Bedient, P.B., Wilson, J.T., Miller, K.M., and J.M. Armstrong "Biodegradation Modeling at an Aviation Spill Site" ASCE J. Environmental Engr. Div. 114:1007-1019 (1988).

69. Satkin, R.L. and P.B. Bedient "Effectiveness of Various Aquifer Restoration Schemes under Variable Hydrogeologic Conditions" Ground Water, 26:488-498 (1988).

70. Todd, D.A. and P B. Bedient "Stream Dissolved Oxygen Analysis and Control" (Closure), ASCE J. Environmental Engr. Div. 113:927-928 (1987).

71. Freeberg, K.M., Bedient, P.B., and J.A. Connor "Modeling of TCE Contamination and Recovery in a Shallow Sand Aquifer" Ground Water 25:70-80 (1987).

72. Borden, R.C. and P.B. Bedient "In Situ Measurement of Adsorption and Biotransformation at a Hazardous Waste Site" Water Resour. Bull. 23(4): 629-636 (1987).

73. Borden, R.C., Bedient, P.B., Lee, M.D., Ward, C.H., and J.T. Wilson " Transport of Dissolved Hydrocarbons Influenced by Oxygen Limited Biodegradation: 2. Field Application" Water Resour. Res. 22:1983-1990 (1986).

74. Borden, R.C. and P.B. Bedient "Transport of Dissolved Hydrocarbons Influenced by Reaeration and Oxygen Limited Biodegradation: 1. Theoretical Development" Water Resour. Res. 22:1973-1982 (1986).

75. C.H. Ward, Tomson, M.B., Bedient, P.B., and M.D. Lee "Transport and Fate Processes in the Subsurface" In R. C. Loehr, and J.F. Malina, Jr., eds., Land Treatment, A Hazardous Waste Management Alternative, Center for Research in Water Resources, University of Texas, Austin, TX, pp. 19-39. (1986).

76. Wilson, J.T., McNabb, J.F., Cochran, J.W., Wang, T.H., Tomson, M.B., and P.B. Bedient "Influence of Microbial Adaptation on the Fate of Organic Pollutants in Ground Water" Environ. Toxicol. Chem. 4:721-726 (1985).

77. Bedient, P.B. "Overview of Subsurface Characterization Research" In Ward, C.H., Giger, W., and P. L. McCarty, eds., Ground Water Quality, John Wiley & Sons, Inc., New York, NY, pp. 345-347 (1985).

78. Bedient, P.B., Flores, A., Johnson, S., and P. Pappas "Floodplain Storage and Land Use Analyses at the Woodlands, Texas" Water Resour. Bull. 21:543-551 (1985).

79. Hutchins, S.R., Tomson, M.B., Bedient, P.B., and C.H. Ward "Fate of Trace Organics During Land Application of Municipal Wastewater" CRC Crit. Rev. Environ. Control 15:355-416 (1985).

80. Todd, D.A. and P.B. Bedient "Stream Dissolved Oxygen Analysis and Control" ASCE J. Environmental Engr. Div. 111:336-352 (June 1985).

81. Chiang, C.Y. and P.B. Bedient "PIBS Model for Surcharged Pipe Flow" ASCE J. Hydraulics Div. 112:181-192 (1985).

82. Bedient, P.B., Borden, R.C., and D.I. Leib "Basic Concepts for Ground Water Transport Modeling" In Ward, C.H., Giger, W., and P.L. McCarty, eds., Ground Water Quality, John Wiley & Sons, Inc., New York, NY, pp. 512-531, (1985).

83. Bedient, P.B., Rodgers, A.C., Bouvette, T.C., and M.B. Tomson "Ground Water Quality at a Creosote Waste Site" Ground Water 22:318-319 (1984).

84. Bedient, P.B. and P.G. Rowe, eds., Urban Watershed Management: Flooding and Water Quality, Rice University Studies, 205 pp. (March 1979).

85. Bedient, P.B., Huber, W.C., and J. Heaney "Environmental Model of the Kissimmee River Basin" ASCE Water Resources Planning and Management, Vol. 103, No. WR2, (1977).

Conference Proceedings and Other Technical Publications

1. Juan, A., Fang, Z., and Bedient, P. B. (2012). "Flood Warning Indicator: Establish a Reliable Radar-Based Flood Warning System for Sugar Land, Texas", American Geophysical Union (AGU) 2012 Fall Meeting, San Francisco, CA, December 3-7.

2. Deitz, R., Christian, J. K., Wright, G., Fang, Z., and Bedient, P. B. (2012). "Linkage of Rainfall-Runoff and Hurricane Storm Surge in Galveston Bay", American Geophysical Union (AGU) 2012 Fall Meeting, San Francisco, CA, December 3-7.

3. Bedient, P. B., Doubleday, G., Sebastian, A., and Fang, Z. (2012). "Distributed Hydrologic Modeling of LID in the Woodlands, Texas", American Geophysical Union (AGU) 2012 Fall Meeting, San Francisco, CA, December 3-7.

4. Burcham, M. ,Bedient,P., McGuire, T., Adamson, D., . New Ch., (2012) Occurrence of Sustained Treatment Following Enhanced Anaerobic Bioremediation at Chlorinated Solvent Sites□, AGU Fall Meeting, San Francisco, California, December 3-7 2012

5. Fang, Z. and Bedient, P., Performance Evaluation of a NEXRAD-Based Flood Warning during Recent Events in 2012□, AGU Fall Meeting, San Francisco, California, December 3-7 2012

6. Juan, A., Fang, Z. and Bedient, P., Radar-based Flood Warning Indicator for the Upper Oyster Creek Watershed in Sugar Land, Texas□ *AGU* Fall Meeting, San Francisco, California, December 3-7 2012

7. Environmental and Water Res. Inst. (EWRI) 2012 Congress, Organized three sessions for SSPEED research results. Albuquerque, New Mexico, May 20-24 2012.

8. Fang, Z. and Bedient, P. B. (2012). "Creating Flood Alert Systems in Coastal Areas", SSPEED Conference – Gulf Coast Hurricanes: Mitigation and Response, Houston, Texas, April 10.

9. Fang, Z. and Bedient, P. B. (2012). "Advanced Radar-Based Flood Warning System for Urban Areas and its Performance Evaluation", SSPEED Conference – Gulf Coast Hurricanes: Mitigation and Response, Houston, Texas, April 11.

10. Teague, A, and Bedient, P. B. (2011). "Visualization of Hydrologic Simulations with Pollutant Load Estimation for Cypress Creek Watershed, Houston, Texas". 2011 World Environmental and Water Resources Congress. Palm Springs California 22-26 May 2011.

11. Christian, J. K., Fang, Z., and Bedient, P. B. (2011). "Probabilistic Floodplain Delineation", 2011 World Environmental and Water Resources Congress, Palm Springs, California. May 22-26

12. Fang, Z., Juan, A., Bedient, P. B., Kumar, S., and Steubing, C. (2011). "Flood Warning Indicator: Establishing a Reliable Radar-Based Flood Warning System for the Upper Oyster Creek Watershed", ASCE/TFMA, TFMA 2011 Annual Conference, Sugar Land, Texas, April 11- 14.

13. Bedient, P. B. and Fang, Z. (2010). "Advanced Radar-based Flood Warning System for Hurricane-prone Urban Areas and Performance during Recent Events", 2nd International Conference on Flood Recovery, Innovation and Response (FRIAR), Milano, Italy, May 26-28.

14. Fang, Z., Juan, A., Bedient, P. B., Kumar, S., and Steubing, C. (2010). "Flood Alert System for Upper Oyster Creek Watershed in Sugar Land, Texas using NEXRAD, HEC-HMS, HEC-RAS, and GIS", ASCE/TFMA, TFMA 2010 Annual Conference, Fort Worth, Texas, June 7- 10.

15. Fang, Z. and Bedient, P. B. (2010). "Radar Applications in Flood Warning System for an Urban Watershed in Houston, Texas", Remote Sensing and Hydrology 2010 Symposium - Special Session on Flood Forecasting and Management with Remote Sensing and GIS, Jackson Hole, WO, September 27 -30.

16. Bedient, P. B., Fang, Z., and Vieux, B. E. (2010). "Radar-based Flood Warning System for the Texas Medical Center and Performance Evaluation", National Flood Workshop, Houston, Texas, October 24-26.

17. Teague, A. and Bedient, P. 2010. "Distributed Modeling of Water Quality in Cypress Creek Watershed, Houston, Texas". 21st Century Watershed Technology: Improving Water Quality and the Environment, EARTH University, Costa Rica, February 21-24, 2010.

18. Teague, A. and Bedient, P. 2010. "Visualization of Hydrologic Simulations in Support of Water Quality Applications for Cypress Creek, Houston, Texas". Conference Proceedings. Annual Water Resources Conference, American Water Resources Association. November 1-4, 2010, Philadelphia, PA.

19. Teague, A. and Bedient, P. 2010. "Distributed Water Quality Modeling for a Drinking Water Source Watershed for the City of Houston, Texas". Conference Proceedings. World Environmental and Water Resources Congress. May 16-20, 2010, Providence, RI.

20. Fang, Z. and Bedient, P.B. (2009). "Radar-based Flood Warning System for Houston and Its Performance Evaluation". American Geophysical Union (AGU) 2009 Fall Meeting, December 14-18, San Francisco, CA.

21. Fang, Z. and Bedient, P.B. (2009). "Radar-based Flood Alert System for Coastal Area and Collaborated Efforts for Disaster Prevention and Risk Management". IRCD 34th Annual Natural Hazards Research and Applications Workshop – Hazards and the Economy: Challenges and Opportunity, July 15-18, Boulder, CO.

22. Fang, Z. and Bedient, P.B. (2009). "Flood Inundation Prediction and Performance during Hurricane Ike". Proceedings of World Environmental & Water Resources Congress 2008, Environmental and Water Resources Institute (EWRI), ASCE, Kansas City, Missouri, May 17-21.

23. Robinson, H., Fang, Z. and Bedient, P.B. (2009). "Distributed Hydrologic Modeling of the Yuna River Watershed in the Dominican Republic". Proceedings of World Environmental & Water Resources Congress 2008, Environmental and Water Resources Institute (EWRI), ASCE, Kansas City, Missouri, May 17-21.

24. Ray, T., Fang, Z., and Bedient, P.B. (2009). "Assessment of Flood Risk Due to Storm Surge in Coastal Bayous Using Dynamic Hydraulic Modeling". Proceedings of World Environmental & Water Resources Congress 2008, Environmental and Water Resources Institute (EWRI), ASCE, Kansas City, Missouri, May 17-21.

25. Fang, Z. and Bedient, P.B. (2009). "Advanced Radar-based Flood Forecasting Systems for a Highly Urbanized Coastal Area and SSPEED Center", ASCE/TFMA Flood Awareness and Flood Response Workshop, April 29, San Marcos, TX.

26. Fang, Z. and Bedient, P.B. (2009). "Flood Warning Systems for Urban Flooding". Grand Challenges in Coastal Resiliency I: Transforming Coastal Inundation Modeling to Public Security, January 20-21, Baton Rouge, LA.

27. Fang, Z. and Bedient, P.B. (2008). "NEXRAD Radar-based Hydraulic Flood Prediction System for a Major Evacuation Routes in Houston". American Geophysical Union 2008 Fall Meeting, December 15-19, San Francisco, CA.

28. Fang, Z. and Bedient, P.B. (2008). "Advanced Flood Alert System with Hydraulic Prediction for a Major Evacuation Route in Houston". Proceedings of American Water Resources Association (AWRA) Annual Conference 2008, New Orleans, Louisianan, November 17-20.

29. Fang, Z. and Bedient, P.B. (2008). "Flood Inundation Prediction and Performance during Hurricane Ile". Proceedings of Severe Storm Prediction and Global Climate Impact in the Gulf Coast Conference 2008, Houston, Texas, October 28-31.

30. Bedient, P.B. and Fang, Z. (2008). "Predicting and Managing Severe Storms in the Gulf Coast through University Research". Proceedings of Severe Storm Prediction and Global Climate Impact in the Gulf Coast Conference 2008, Houston, Texas, October 28-31.

31. Robinson, H., Fang, Z. and Bedient, P.B. (2008). "Distributed Hydrologic Model Development in the Topographically Challenging Yuna River Watershed, Dominican Republic". Proceedings of Severe Storm Prediction and Global Climate Impact in the Gulf Coast Conference 2008, Houston, Texas, October 28-31.

32. Ray, T., Fang, Z. and Bedient, P.B. (2008). "Assessment of Flood Risk Due to Storm Surge in Coastal Bayous Using Dynamic Hydraulic Modeling". Proceedings of Severe Storm Prediction and Global Climate Impact in the Gulf Coast Conference 2008, Houston, Texas, October 28-31.

33. Fang, Z. and Bedient, P.B. (2008). "Floodplain Map Library (FPML): Innovative Method for Flood Warning System for Urban Watershed in Houston, TX". Proceedings of World Environmental & Water Resources Congress 2008, Environmental and Water Resources Institute (EWRI), ASCE, Honolulu, Hawaii, May 13-16.

34. Bedient, P.B., "Foresight Panel on Environmental Effects" Houston-Galveston Area Council, Houston, Texas, February 5, 2008

35. Bedient, P.B., Fang, Z., Hovinga, R,M., "Flood Warning System (FAS_2) Rice University Training, Houston, Texas, January 15, 2008

36. Bedient, P.B., Fang, Z., Hovinga, R,M., SSPEED Meeting, Houston, Texas, November 16, 2007

37. Fang, Z. and Bedient, P.B. "Real-time Hydraulic Prediction Tool – FloodPlain Map Library (FPML)". American Water Resources Association 2007 Annual Conference, Albuquerque, New Mexico, November 12-15, 2007

38. Fang, Z. and Bedient, P.B. "Enhanced NEXRAD Radar-based Flood Warning System with Hydraulic Prediction Feature: Floodplain Map Library (FPML)". American Geophysical Union 2007 Fall Meeting, San Francisco, CA. December 10-14, 2007

39. Fang, Z. and Bedient, P.B. "The Future of Flood Prediction in Coastal Areas" Severe Storm Prediction, Evacuation, and Education from Disasters Conference, Rice University, Houston Texas, May 8-10, 2007

40. Bedient, P.B. and Fang, Z. "Radar-based Flood Warning System Using Dynamic Floodplain Map Library." Proceedings of World Environmental & Water Resources Congress 2007, Environmental and Water Resources Institute (EWRI), ASCE, Tampa, Florida, May 15-19, 2007

41. Bedient, P.B., and C. Penland "A Radar Based FAS for Houston's Texas Medical Center" IDRC Conference, Davos, Switzerland, Aug, 2006.

42. Safiolea, E. and P.B. Bedient "Comparative Analysis of the Hydrologic Impact of Land Use Change and Subsidence in an Urban Environment" Proceedings of AWRA GIS Conference, Houston, TX, May 8-10, 2006.

43. Bedient, P.B., Fang, Z., and R. Hovinga "Prediction for Severe Storm Flood Levels for Houston Using Hurricane Induced Storm Surge Models in GIS Frame" Proceedings of AWRA GIS Conference, Houston, TX, May 8-10, 2006.

44. Fang, Z., Safiolea, E., and P.B. Bedient "Enhanced Flood Alert and Control Systems for Houston" Proceedings of 25th American Institute of Hydrology Conference, Baton Rouge, LA, May 21-24, 2006.

45. Gordon, R. and P.B. Bedient "Rice University Engineers Without Borders: An Exercise in International Service Learning" Proceedings of the ASEEducation Conference, Chicago, June 18-21, 2006.

46. Gordon, R., Benavides, J.A., Hovinga, R., Whitko, A.N., and P.B. Bedient "Urban Floodplain Mapping and Flood Damage Reduction Using LIDAR, NEXRAD, and GIS" Proceedings of the 2006 AWRA Spring Specialty Conference: GIS and Water Resources IV, Houston, TX, May 8-10, 2006.

47. Fang, Z. and P.B. Bedient "IP2 Houston Flood Alert and Response-2006" CASA Meeting, Estes Park, Co, October 16-17, 2006.

48. Safiolea, E., Bedient, P.B., and B.E. Vieux "Assessment of the Relative Hydrologic Effects of Land Use Change and Subsidence Using Distributed Modeling" (July 2005).

49. Holder, A.W., Hoblit, B., Bedient, P.B., and B.E. Vieux "Urban Hydrologic Forecasting Application Using the NEXRAD Radar in Houston" Proceedings of the Texas Section American Society of Civil Engineers, Austin, TX, pp. 279-288, April 5-8, 2000.

50. Benavides, J.A., Pietruszewski, B., Stewart, E., and P.B. Bedient "A Sustainable Development Approach for the Clear Creek Watershed" Proceedings of the Texas Section American Society of Civil Engineers, Austin, TX, pp. 269-278, April 5-8, 2000.

51. Bedient, P.B., Rifai, H.S., and C.W. Newell "Decision Support System for Evaluating Pump-and-Treat Remediation Alternatives" Pollution Modeling: Vol. 1, Proceedings for Envirosoft 94, November 16-18, 1994, San Francisco, CA, Edited by P. Zannetti, Computational Mechanics Publications, Wessex Inst of Technology, Southampton, UK.

52. Hamed M.M. and P.B. Bedient "Uncertainty Analysis of Natural Attenuation in Groundwater Systems," Proceedings of the In Situ and On-Site Bioremediation Symposium, New Orleans, LA, 1997, 1:43-48.

53. Hamed, M.M., Holder, A.W., and P.B. Bedient "Evaluation of Reaeration Using a 3-D Groundwater Transport Model" Proceedings of the In Situ and On-Site Bioremediation Symposium, New Orleans, LA, 1997, 1:75-80.

54. Holder, A.W., Bedient, P.B., and J.B. Hughes "TCE and 1,2-DCE Biotransformation Inside a Biologically Active Zone" Proceedings of the First International Conference on Remediation of Chlorinated and Recalcitrant Compounds, Monterey, CA, May 18-21, 1:219-224, 1998.

55. Hamed M.M. and P.B. Bedient "Uncertainty Analysis of Natural Attenuation in Groundwater Systems" Proceedings of the In Situ and On-Site Bioremediation Symposium, New Orleans, LA, 1997, 1:43-48.

56. Hamed, M.M., Holder, A.W., and P.B. Bedient "Evaluation of Reaeration Using a 3-D Groundwater Transport Model" Proceedings of the In Situ and On-Site Bioremediation Symposium, New Orleans, LA, 1997, 1:75-80.

57. Hamed, M.M., Bedient, P.B., and J.P. Conte "Probabilistic Modeling of Contaminant Transport in the Subsurface" Proceedings of the International Association of Hydrogeologists Conference Solutions '95", Edmonton, Canada, June 4-10, 1995.

58. Bedient, P.B., Rifai, H.S., and C.W. Newell "Decision Support System for Evaluating Pump-and-Treat Remediation Alternatives" Pollution Modeling: Vol. 1, Proceedings for Envirosoft 94, November 16-18, 1994, San Francisco, CA, Edited by P. Zannetti, Computational Mechanics Publications, Wessex Institute of Technology, Southampton, UK.

59. Burgess, K. S., Rifai, H. S., and P. B. Bedient "Flow and Transport Modeling of a Heterogeneous Field Site Contaminated with Dense Chlorinated Solvent Waste" Proceedings of the Petroleum Hydrocarbons and Organic Chemicals in Ground Water: Prevention, Detection, and Restoration, Houston, TX (Nov. 10-12, 1993).

60. Hamed, M., Conte, J., and P. B. Bedient "Reliability Approach to the Probabilistic Modeling of Ground Water Flow and Transport" Proceedings of the Petroleum Hydrocarbons and Organic Chemicals in Ground Water: Prevention, Detection, and Restoration, Houston, TX (Nov. 10-12, 1993).

61. Rifai, H.S. and P.B. Bedient "Ground Water Contaminant Modeling for Bioremediation: A Review" Proceedings of the 4th Annual Symposium on Ground Water: The Problem and Some Solutions, The Gulf Coast Hazardous Substance Research Center, Lamar University, Beaumont, Texas, 101-121 (April 2-3, 1992).

62. Thomas, J.M., Duston, K.L., Bedient, P.B., and C.H. Ward "In Situ Biorestoration of Contaminated Aquifers and Hazardous Waste Sites in Texas" Proceedings for the Petro-Safe 92, 3rd Annual Environmental and Safety Conference for the Oil, Gas & Petrochemical Industries, Houston, TX, Vol. 3, pp. 889-898 (1992).

63. Bedient, P.B., Long, G.P., and H.S. Rifai "Modeling Natural Biodegradation with BIOPLUME II" Proceedings of the 5th International Conference, Solving Ground Water Problems with Models, Dallas, Texas, pp 699-714. (February 11-13, 1992).

64. Robinson, G.C. and P.B. Bedient "Modeling a Time-Variant Source of Contamination" Proceedings of the Petroleum Hydrocarbons and Organic Chemicals in Ground Water: Prevention, Detection, and Restoration, Houston, Texas, pp. 531-540. (November 20-22, 1991).

65. Chang, C. and P. B. Bedient "Multiphase Unsaturated Zone Flow and Transport Model for Ground Water Contamination by Hydrocarbon" Proceedings of the Petroleum Hydrocarbons and Organic Chemicals in Ground Water: Prevention, Detection, and Restoration, Houston, Texas, pp. 515-529 (November 20-22, 1991).

66. Bedient, P.B., Vance, L.A., and H.S. Rifai "Implementation of Wellhead Protection Programs Utilizing Geographical Information Systems" Proceedings of the Eighth National Conference on Microcomputers in Civil Engineering, University of Central Florida and The American Society of Civil Engineers, Orlando, Florida, pp. 87-90 (October 1990).

67. Rifai, H.S., Bedient, P.B., and C.J. Newell "Review and Analysis of the Toxicity Characteristics Composite Landfill Model" Proceedings of the Petroleum Hydrocarbons and Organic Chemicals in Ground Water: Prevention, Detection and Restoration, The Association of Ground Water Scientists and Engineers (NWWA), Houston, Texas, pp.143-157 (October 1990).

68. Rifai, H.S. and P.B. Bedient "A TC Model Alternative for Production Waste Scenarios" Proceedings of the First International Symposium on Oil and Gas Exploration and Production Waste Management Practices, U.S. Environmental Protection Agency, New Orleans, LA, pp. 955-965 (September 1990).

69. Chang, C.C., Wise, W.R., Klopp, R.A., and P.B. Bedient "In Situ Source Release Mechanism Study at an Aviation Gasoline Spill Site: Traverse City, Michigan" Proceedings of the Fourth National Outdoor Action Conference on Aquifer Restoration, Ground Water Monitoring and Geophysical Methods, Las Vegas, NV, pp. 459-473 (May 1990).

70. Hopkins, L.P., Newell, C.J., and P.B. Bedient "A Hydrogeologic Database for the Hazardous Waste Regulatory Modeling" Proceedings of the Petroleum Hydrocarbons and Organic Chemicals in Ground Water Conference, National Water Well Association, Houston, TX, pp. 265-279 (November 1989).

71. Alder-Schaller, S.E. and P.B. Bedient "Evaluation of the Hydraulic Effect of Injection and Pumping Wells on In Situ Bioremediation" Proceedings of the Petroleum Hydrocarbons and Organic Chemicals in Ground Water Conference, National Water Well Association, Houston, TX, pp. 191-201 (November 1989).

72. Smythe, J.M., Bedient, P.B., and R.A. Klopp "Cone Penetrometr Technology for Hazardous Waste Site Investigations" Proceeding of the Second National Outdoor Action Conference on Aquifer Restoration, Ground Water Monitoring and Geophysical methods, Association of Ground Water Scientists and Engineers, Las Vegas, NV, pp. 71-94 (1989).

73. Rifai, H.S. and P.B. Bedient "Biorestoration Modeling of a Pilot Scale Field Experiment" Proceedings of the National Water Well Association on Solving Ground Water Problems with Models, Indianapolis, IN, pp. 1187-1203 (1989).

74. Wheeler, M.F., Dawson, C., and P.B. Bedient "Numerical Modeling of Subsurface Contaminant Transport with Biodegradation Kinetics" Proceedings of the NWWA Conference on Petroleum Hydrocarbons and Organic Chemicals in Ground Water, Houston, TX, pp. 471-489 (1987).

75. Newell, C.J. and P.B. Bedient "Development and Application of a Ground Water Modeling Database and Expert System" Proceedings of the NWWA Conference on Petroleum Hydrocarbons and Organic Chemicals in Ground Water, Houston, TX, pp. 559-578 (1987).

76. Rifai, H.S. and P. B. Bedient "BIOPLUME II - Two Dimensional Modeling for Hydrocarbon Biodegradation and In Situ Restoration" Proceedings of the NWWA Conference on Petroleum Hydrocarbons and Organic Chemicals in Ground Water, Houston, TX, pp. 431-450 (1987).

77. Wheeler, M.F., Dawson, C.N., and P.B. Bedient "Numerical Simulation of Microbial Biodegradation of Hydrocarbons in Ground Water" Proceedings of the NWWA/IGWMC Conference on Solving Ground Water Problems with Models, Denver, CO, February 10-12, Vol. 1, pp. 92-109 (1987).

78. Chiang, C.Y. and P.B. Bedient "Simplified Model for a Surcharged Stormwater System" Proceedings of the Third Int'l Conf. on Urban Storm Drainage, Goteborg, Sweden, pp. 387-396 (1985).

79. Wang, T.H., Curran, C.M., Bedient, P.B., and M.B. Tomson "Ground Water Contamination at Conroe Creosote Waste Disposal Site" Proceedings of the Second Int'l Conf. on Ground Water Quality Research, OSU University Printing Services, Stillwater, OK, pp. 50-52 (1985).

80. Borden, R.C., Bedient, P.B., and T. Bouvette "Modeling Ground Water Transport at Conroe Creosote Waste Site" Proceedings of the Second Int'l Conf. on Ground Water Quality Research, OSU University Printing Services, Stillwater, OK, p. 88-90 (1985).

81. Todd, D.A. and P.B. Bedient "Use of Qual-II to Model Stream Protection Alternatives" Proceedings of the ASCE 1984 National Conference on Environmental Engineering, Los Angeles, CA, June 1984, pp. 60-65 (1984).

Invited Lectures (Recent)

1. The Resilience and Adaptation to Climate Risks Workshop: NASA Johnson Space Center and the Houston/Galveston Area, March 8, 2012, Houston, Texas

2. Bedient, P.B., SSPEED Conference. Chair and Organizer, "*Hurricane Ike, Revisited,*" September 14, 2009, Houston, Texas.

3. Bedient, P.B., SSPEED Conference. Chair and Organizer, "*Severe Storm Prediction and Global Climate Impact in the Gulf Coast,*" Sponsored by American Institute of Hydrology. October 29-31, 2008, Houston, Texas. (Attended by over 150 guests and speakers).

4. Bedient, P.B., SSPEED Conference. Chair and Organizer, "*Severe Storm Prediction and Global Climate Impact in the Gulf Coast,*" Sponsored by American Institute of Hydrology. October 29-31, 2008, Houston, Texas. (Attended by over 150 guests and speakers).

5. Bedient, P.B., Robinson, and H., Fang, Z. (2008). "Distributed Hydrologic Model Development in the Topographically Challenging Yuna River Watershed, Dominican Republic". Meeting in Dominican Republic before the President October 20, 2008.

6. Bedient, P.B. (June, 2008) Plan for the Dominican Republic Flood Study, before the Ministers of Education, Environment, and Economic Development.

7. Bedient, P.B. "Advanced Flood Alert Systems in Texas" International Disaster Response Conference, Daves, Switzerland, August 28, 2006.

8. Bedient, P.B. "IP2 Flood Alert System for Houston" CASA Meeting NSF Review, UMASS. April, 2006.

9. Bedient, P.B. "Severe Storm Impacts in the Gulf Coast" Severe Storm Impacts and Disaster Response in Gulf Coast, Houston, Rice University, March 15-16, 2006.

10. Bedient, P.B. "Living with Severe Storms in the Gulf Coast- Scientia Lecture" Rice University, Houston, TX. (September 2005).

11. Bedient, P.B., Fang, Z., Safiolea, E., and B.E. Vieux "Enhanced Flood Alert System for Houston" 2005 National Hydrologic Council Conference: Flood Warning Systems, Technologies and Preparedness, Sacramento, California. (May 16-20)

12. Fang, Z. and Bedient, P.B. "Enhanced Flood Alert and Control Systems for Houston" Proceedings of the 25th American Institute of Hydrology Conference: Challenges of Coastal Hydrology and Water Quality. Baton Rouge, Louisiana, May 21-24, 2006.

13. Fang, Z., Bedient, P.B., and R. Hovinga "Prediction of Severe Storm Flood Levels for Houston Using Hurricane Induced Storm Surge Models in a GIS Frame" Proceedings of AWRA 2006 Spring Specialty Conference: GIS and Water Resources IV. Houston, Texas, May 8-10, 2006.

14. Bedient, P.B. "Impacts of Climate Change on Transportation Systems and Infrastructure" Gulf Coast Study, Lafayette, LA. (May 2005)

15. Capiro, N.L., Da Silva, M.L.B., Stafford, B.P., Alvarez, P.J.J., and P.B. Bedient "Changes in Microbial Diversity Resulting from a Fuel-Grade Ethanol Spill" Eighth International Symposium on In Situ and On-Site Bioremediation, Baltimore, MD. (June 2005).

16. Safiolea, E. and P. B. Bedient "Assessment of the Relative Hydrologic Effect of Land Use Change and Subsidence Using Distributed Modeling" EWRI Watershed Management Conference, Williamsburg, VA. (July 9-22, 2005)

17. Capiro, N.L., Stafford, B., He, X., Rixey, W.G., and P.B. Bedient "A Large-Scale Experimental Investigation of Ethanol Impacts on Groundwater Contamination" Presentation at the Fourth International Conference on Remediation of Chlorinated and Recalcitrant Compounds; Monterey, CA; May 2004.

18. Capiro, N.L., Da Silva, M.L.B., Stafford, B.P., Alvarez, P.J.J., and P.B. Bedient "Changes in Microbial Diversity Resulting from a Fuel-Grade Ethanol Spill" Accepted for Presentation at The Eighth International Symposium on In Situ and On-Site Bioremediation; Baltimore, MD. June 2005.

19. Safiolea, E. and P.B. Bedient "Analysis of Altered Drainage Patterns and Subsidence Impact Using a Distributed Hydrologic Model" AWRA Annual Water Resources Conference in Orlando FL, November, 2004.

20. Safiolea, E. and Philip B. Bedient " Assessment of the Relative Hydrologic Effect of Land Use Change and Subsidence using Distributed Modeling" EWRI Watershed Management Conference in Williamsburg VA, Jul19-22, 2005.

21. Bedient, P.B. and J.A. Benavides "Use of QPE and QPF for Flood Alert (FAS2) in the Houston, TX Test Bed" CASA NSF ERC Conference, " Estes Park, CO, October, 2004.

22. Capiro, N.L., Adamson, D.T., McDade, J.M., Hughes, J.B., and P.B. Bedient "Spatial Variability of Dechlorination Activity Within a PCE DNAPL Source Zone" Presentation The 7th International Symposium In Situ and On-Site Bioremediation; Orlando, FL; June 2003

23. Benavides, J.A. and P.B. Bedient "Improving the Lead-Time and Accuracy of a Flood Alert System in an Urban Watershed" 2003 AWRA Annual Conference, San Diego, California, November 2003.

24. Whitko, A.N. Bedient, P.B., and S. Johnson "Sustainable Flood Control Strategies in the Woodlands – Thirty Years Later" 2003 AWRA Annual Conference, San Diego, California, November 2003.

25. Safiolea E., Hovinga, R., and P.B. Bedient " Impact of Development Patterns on Flooding in Northwest Houston using LIDAR Data" 2003 AWRA Annual Conference, San Diego, California, November 2003

26. Benavides, J.A. and P.B. Bedient "Improving the Performance of a Flood Alert System Designed for a Rapidly Responding Urban Watershed" 2003 Conference on Flood Warning Systems Technologies and Preparedness, Dallas, Texas. October 2003.

27. Bedient, P.B., Holder, A., and Baxter Vieux "A Radar-Based Flood Alert System (FAS) Designed for Houston, TX" *International Conference on Urban Storm Drainage*, Portland, OR, September 2002.

28. Holder, A., Stewart, E., and P.B. Bedient "Modeling an Urban Drainage System with Large Tailwater Effects under Extreme Rainfall Conditions" *International Conference on Urban Storm Drainage*, Portland, OR, September 2002.

29. Glenn, S., Bedient, P.B., and B. Vieux "Analysis of Recharge in Ground Water Using NEXRAD in a GIS Format" *AWRA Summer Specialty Conference*, Keystone, CO, July, 2002.

30. Bedient, P.B. "Flood ALERT System (FAS) for Brays Bayou and the TMC" T.S. Allison: A Brays Bayou Event, Rice University Conference Presentation, November 13, 2001.

31. Bedient, P.B. "Flood ALERT System for the Texas Medical Center" Hurricanes and Industry, Houston Conference Presentation, November 7, 2001.

32. Bedient, P.B. and J.A. Benavides "Analyzing Flood Control Alternatives for the Clear Creek Watershed in a Geographic Information Systems Framework" presented at ASCE's EWRI Spring 2001 World Water & Environmental Resources Congress Conference.

33. Hoblit, B.C., Bedient, P.B., B.E. Vieux, and A. Holder "Urban Hydrologic Forecasting: Application Issues Using WSR-88D Radar" *Proceedings American Society of Civil Engineers Water Research, Planning and Management 2000 Conference*, Minneapolis, MN, August 2000.

34. Spexet, A., Bedient, P.B., and M. Marcon "Biodegradation and DNAPL Issues Associated with Dry Cleaning Sites" *Proc. Natural Attenuation of Chlorinated Solvents, Petroleum and Hydrocarbons Conference*, Bruce Alleman and Andrea Leeson eds., 5(1), pp. 7-11, Battelle Press, Columbus, Ohio, 1999.

ATTACHMENT B

Review of the LCP Chemicals Site, Brunswick, GA.

By Loren H. Raun, Ph.D.

March 13, 2015

Loren H. Raun

P. B. Bedient and Assoc., Inc

Review of the LCP Chemicals Site, Brunswick, GA.

I was retained on this project for the purpose of evaluating the development of the remedial goals proposed for the estuary impacted by the LCP Chemicals Site. My opinions are based on my professional experience in human health risk assessment, environmental science, environmental statistics and hydrogeology and review of relevant data summaries, figures and documentation to date, and are subject to change if and when additional information becomes available.

Section I. Qualifications

My educational background, research and professional experience and the review of documents provided are the basis of my opinions. I hold a Ph.D. degree from Rice University in Houston in Environmental Science and Engineering and a B.S. in geophysics from the University of Texas in Austin, and I have attached a curriculum vita including a list of peer-reviewed publications. I am a research faculty fellow in the Department of Statistics at Rice University, where I have been on faculty since 2003, and teach courses in human health risk assessment and environmental statistics. My research focuses most heavily on tracking health effects from pollution exposure. I have extensive experience as a risk assessment reviewer for state and local governments and have served on EPA Science Advisory Board, Risk and Technology Review Methods Panel.

Section II. Comments on Development of Remedial Goals

The ultimate selection of remedial goals (RGOs) for the estuary and the method to achieve these goals is based on analysis of a complex interaction between the contamination in sediment, surface water, groundwater, soil and human and ecological receptors. Although much data have been collected and sophisticated models used, there is a large degree of uncertainty associated with the RGOs. In the thousands of pages of analysis there are times when conservative assumptions (i.e., which would result in more restrictive RGOs) were applied but there are equally multiple junctures where decisions were made which result in underestimation of risk and RGOs. The overarching concern is that RGOs be protective in spite of the uncertainties and that remediation attains these RGOs in this dynamic environment. In general some factors which could compound to underestimate the RGO or add to the uncertainty in this FS include:

Failing to add risk from OU3 when estimating the RGO for OU1- The contamination has been separated into three operable units (OU) for study and management. These units are the original site (OU3), the groundwater (OU2) and the estuary (OU1). The RGOs for the estuary were developed based on a baseline human health risk assessment and ecological risk assessment. As part of the risk assessment, receptors are identified. An important receptor in the OU1 risk assessment is the high rate consumer of seafood. Important receptors for the OU3 risk assessment are the onsite resident, worker or trespasser. Risk assessment requires that all exposure pathways for a receptor be considered. Clearly, the high rate seafood consumer could also be a resident, worker or trespasser. In other words, the risk for the high rate consumer should be added to the risk of receptors considered in the OU3 risk assessment, and RGOs developed based on the added risk. While it is acceptable to separate the contamination into operable units for management, it is not justifiable to consider the risk in an operable unit in a vacuum.

Failing to add the risk from exposure to surface water or sediment- Within the risk assessment conducted for OU1, risk from human exposure to surface water and sediment were not included in the development of RGOs. The only risk considered was consumption of seafood. Any risk added from these other pathways would result in lower RGOs.

Underestimating consumption of contaminated food by relying on default exposure factors especially given a large portion of the local community is below the poverty level (exposure frequency, ingestion rate), and likely a sensitive subpopulation- The risk assessment relies on default exposure factors to estimate the intake of the seafood for the high rate consumer. A better understanding of the local consumption pattern is extremely important to correctly calculate the risk from seafood ingestion. With a high percentage of individuals and families below the poverty level, the community may be relying heavily on seafood for meals. It is conceivable that more than one meal a day is seafood. The exposure frequency could easily be underestimated. The intake rate (the amount of seafood eaten per meal) used in the risk assessment may also be underestimated. The relationship between income and weight (and presumably intake) can vary by gender, race-ethnicity and age. Increase in intake or exposure frequency will add risk for the consumption of seafood and result in lower RGOs.

Misrepresenting concentration levels by not including statistical confidence- Samples are taken to estimate concentrations of the true population parameters (e.g., mean) in a media or seafood. While the true population parameter is not known, we can identify an interval within which we are statistically confident the parameter may fall. It is never appropriate to assume the sample average is the true mean, instead the upper or lower limit of the confidence limit is used. The sample average is used repeatedly in the FS to represent the true mean and no confidence intervals are presented. This adds to the uncertainty in the RGOs, depending upon where it is applied it will raise or lower the RGOS.

Basing decisions on small sample sizes without enough statistical power. Samples are taken in a media and compared to a threshold (standard) or concentrations from a previous year. It is not appropriate to compare a sample average to limits or other distributions directly. The comparison must consider the variability of the data (see previous comment) and the statistical power. The statistical power is a measure of whether enough samples were collected to be able to detect a difference between the concentrations and the threshold if one existed. All other factors being equal, more samples are required for highly variable data than lower variable data. Power is never discussed in this FS.

Misrepresenting decreases in concentration which are not statistically significant. Environmental data vary in time for many reasons. The determination of if a concentration is decreasing in a media is conducted with a statistical trend test. It is not appropriate or sound science to present a graph or concentrations and state they are decreasing without discussing if the decrease is statistically significant.

Screening out COCs which did not exceed screening levels/standards or were present in the background. When chemicals of concern are screened out of the risk assessment because they were below a standard or were present in the background, an analysis of the impact on the RGOs if they had been included in the risk assessment is appropriate in an uncertainty analysis. The polycyclic aromatic hydrocarbons found at the site are also found in the background, however they do pose an involuntary risk to the community from the environment and therefore should be consider in some manner. The COCs below a surface water screening level or sediment screening level could contribute risk and impact the RGOs, especially for example, if screening levels were developed assuming 1x10-5 risk as an acceptable limit.

In general some factors which would interfere with the attainment of the RGO include:

- Discharge from groundwater to the estuary; no explanation is provided for why the remediated area has increased in concentration
- Use of the sample arithmetic average to calculate the RGO when this value should be used to estimate the limits of the true mean and should be evaluated using a method consistent with the underlying distribution of the data
- Selection of 50 foot grid cell averages which dilute the cell average
- Comparison of average to limit without incorporating statistical confidence (as discussed previously)

Specific discussion of all of these general uncertainties is not feasible given the extent of the analysis. However, specific discussion with respect to some aspects of the uncertainties are included below.

<u>Specific Comments</u>

Groundwater- Groundwater was not included in the risk assessment or evaluation of the remedy although it is heavily contaminated and in contact with the surface water. The report indicates that seeps directly along the formerly remediated area and up gradient of Eastern Creek do discharge contaminated groundwater, however, modeling indicates surface water dilution would make the contribution negligible. There are several concerns associated with this conclusion.

It is apparent that sediment contamination exists around the area remediated in 1999. It is possible that this is empirical evidence that the seeps are recontaminating the formerly remediated area and therefore, groundwater is in fact acting as a continuous source. The report uses a simple mass flux calculation to estimate the mass that the groundwater could contribute. The analysis indicated that the concentrations from the groundwater could not account for the concentration now seen in the remediated area. However, there is no explanation given as to how the concentration increased since the remediation. In a situation where a model does not match the measured values, it would be helpful to pinpoint what model input would in fact create such a concentration. Is it physically possible to re-contaminate from the groundwater to the level found? The model input was conservative but not necessarily correct. There are multiple areas of uncertainty including: the use of some filtered groundwater sample concentrations when unfiltered are more appropriate for the pcbs and mercury (only unfiltered should be use), the gradient from two events (no indication if events reflect high or low conditions), the assumption of homogeneity in the lithology, constant flow direction, variable height of surface water. If the recontamination concentration could not be achieved from the groundwater, is there another source that should be considered such as the OU3 surface soils which are also not included in the evaluation of the estuary. An increase after remediation indicates we do not know the full extent of the current contamination as it is increasing in some locations.

The report then indicates that the concentrations discharged to the surface water from contaminated groundwater would not pose any concern because they would be diluted by the surface water. There are concerns with this analysis also. First, the report has established that the COCs of mercury and PCBs are not found in filtered surface water but in the colloidal suspension or in the sediment. If the groundwater discharges contamination to surface water, the contamination will partition more heavily to the sediment. Dilution will have a limited impact. Dilution assumes something like complete mixing. The report indicates that the area around the upper reaches do not experience inundation and therefore, complete mixing is not expected. Clearly, the Eastern Creek has received the brunt of the contamination. This may be because the location acts as a sink. Complete mixing would not occur in a sink.

There is a discussion of dilution of the seep pore water samples down to insiginificant levels. Groundwater would seep when the hydraulic head in the groundwater is higher than the surface water. Groundwater could reasonably seep into a bank above the water level contaminating the soil and sediment.

The report presents the difference in mercury concentration in surface water when only examining dissolved phase and when examining total. The information presented about the seep sampling does not indicate if the samples were filtered. The results could be highly misleading if the concentrations presented are in fact from filtered samples. Likewise, we do not expect to see PCBs in the dissolved phase but in the colloids in the sample.

The report indicates that the seeps occur where the water bearing sand is exposed along the marsh edges. Does the remedy consider the seeps? Will the seeps be aggravated by the remedy? Should the groundwater be retained near these surfaces, especially in the vicinity of transect 1 where concentrations are highest?

Fish Tissue

Appendix F is first discussed in the FS in terms of decrease in concentration of fish concentration over time. It is referenced in Figure 6-4B. The figure graphically shows the concentration range for striped mullet over time. While the concentrations in 2011 appear lower, and may be lower in reality, there is no statistically significant difference between the 2011 and 2007 concentrations according to this data. There are not enough samples to detect a difference between the concentrations (i.e., not enough statistical power).

This appendix presents a comparison of the change in concentration in seafood over the years from the Turtle River and the associated safe concentration level. The safe concentration intake level (gm/day) related to meals per week, is based on the level associated with the carcinogenic risk (limit = 1x10-4) or non-cancer hazard (limit =1), whichever is more restrictive. The calculation assumes 30 year exposure, 70 kg adult, and 70 year lifetime. There are three main issues which result in bias in the presentation of this data:

<u>Comparison between concentrations in seafood between years does not consider statistical confidence.</u>

The main report indicates that the concentration in seafood has decreased. The text of the FS focuses on the fish advisories showing decreases across years. While the advisories have decreased, this implies that the concentrations in the fish have decreased near the site. The decrease is largely overstated according to the data shown in Figure F-3B. It is not appropriate to compare the sample means or individual levels to benchmarks (as shown in the Figure) without considering the statistical confidence, especially with so few samples (sample size of 1 to 3). Sample sizes this low have very limited statistical power. Limiting this critique to comparisons with at least 3 samples, Figure F-3B data appear to indicate that are there two seafood types with a statistically significant decrease in concentration. Estimating concentrations from the plot of those types of seafood, blue crab and white shrimp may have a statistically significant decrease while striped mullet, black drum, southern kingfish and spotted seatrout do not. There is uncertainty because of the low sample size, and the lack of use of statistics to provide a quantitative conclusion introduces a sense that the report is not presenting straightforward results but a bias.

Comparison between concentrations in seafood to the advisory threshold does not consider statistical confidence.

In addition, although the same plot implies that the mean of the blue crab was greater than the 1 meal per month limit in 2002 while in 2011 it is below that limit, this implication is not statistically founded. When the concentration of blue crab are statistically compared to the benchmark (95^{th} upper confidence limit of the blue crab), the concentrations are not below the 1 meal per month limit. This analysis of eyeball comparison is unsophisticated and tends toward bias.

Additive Risk not considered

Unfortunately, the seafood advisories appear to consider only one contaminant at a time, when a fish could actually contain both mercury, lead and PCBs. Where the risk may be below a 1 meal per month limit for PCB and mercury individually, the summation may exceed the limit. In addition, a similar scenario of additive risk exceeding a limit could occur if the risk was below the 1 meal per month limit for blue crab and for shrimp but if a receptor ate both, they could be above the limit. The 1 meal per month limit is based on the risk of 1x10-4 per seafood type per chemical. This type of simplification is not protective with multiple contaminants impacting many different types of seafood.

Development of RGOs and Determination of Areas Exceeding RGOs

Appendix G: Letter from EPA to Mr Gupta Re: Human Health Risk Assessment for the Estuary, Operable Unit One (OU 1): LCP Chemicals Superfund Site, Brunswick, Glynn County, Georgia

In development of the RGOs the only pathway that the EPA considers is consumption of fish. The risk from a local resident or trespasser exposure to OU3 or sediments from OU1 should be added to the ingestion of contaminated food (finfish, clapper rail and shell fish). If the trespasser or resident also ate contaminated food, the carcinogenic risk would increase by as much as 3.3E-6, and 5.2E-5, respectively. These additions would result in a lowering of the sediment RGOs.

Attachment A presents the method to calculate area weighted average. While spatial weighting between the areas is reasonable, use of the average to represent an area is not statistically appropriate. The sample average is only an estimate of the mean concentration and will vary depending upon the number of samples collected. The true mean must be estimated through a confidence interval. The human health risk assessment consistently used the 95th upper confidence limit of the mean with reference to EPA guidance requiring this. However there is not parity in the use of statistics or the sophistication of the statistics used in the FS or in the ecological risk assessment. Statistical confidence should be considered in the calculation in Attachment A. There is not enough information provided to determine if the underlying distribution of the data are normal. The data are likely not normal and contain high concentration outliers therefore, more sophisticated statistical methods should be employed within each area.

In the case of calculating the RGO, the *lower confidence limit* should be used. The outliers would have biased the spatial weighted area arithmetic averages high. The assumption of the Attachment is that fish body burden is related to the sediment. The sediment remedial goal was calculated as the sediment concentration divided by the hazard index or risk. Therefore, if the value used to represent the concentration is higher than it should be (e.g., the skewed arithmetic average instead of the lower confidence limit of the mean), the RGOs will be higher than they should be.

For example, the RGO for the clapper rail is currently:

Target tissue at 1e-4 risk: 19.42/1.54e-4= x/1e-4, I x=12.95

Sed RGO: 19.42/3.408 mg/kg average=12.95/x, x=2.3

If the concentration was lower than 3.408 by 1 mg/kg (which it could easily be given the range of concentrations), then the RGO would be 1.6 mg/kg instead of 2.3 mg/kg: The BAF approach is also dependent on the sediment concentration and would be equally impacted.

Identification of areas exceeding RGOs was also based on arithmetic average without consideration for statistical confidence in some location.

Cost of Remediation/Selection of Remedy

The restrictions on fishing, the potential health consequences due to exposure and the stress of living in or near a contaminated area have inflicted a burden on the local community. According to the census, this community is largely African American and between a quarter to just under a third of the population live below the poverty level. The cost associated with this burden is not considered in the remedy evaluation. Fishing advisories will not keep hungry community members from eating contaminated seafood. The cost savings from avoiding adverse health should be considered. Choosing a remedy which will provide the fastest route to safe levels with limited uncertainty should be the main objective. The most reliable remedy is removal. Considering the uncertainty in this assessment, the more protective RGOs should be applied.

The report indicates that the dredging would be more damaging to the habitat than other remedial measures, however, the previously remediated area recovered much sooner than anticipated (two years). In addition, the contamination is on the surface of the sediment, not at depth. Therefore, the contaminants should be removed and the marsh replanted in the same manner as the previously remediated area.

Section III. Documents Reviewed

1. *April, 2011 Baseline Ecological Risk Assessment for the Estuary at the LCP Chemical Site in Brunswick, Georgia, Site Investigation/Analysis and Risk Characterization (Revision 4)*
2. *April, 2011 Human Health Baseline Risk Assessment for the Estuary, Operable Unit 1, Marsh Trespasser, Fish and Shellfish Consumer, Clapper Rail Consumer, Final, LCP Chemicals Superfund Site, Brunswick, Georgia*
3. *January 2012 Human Health Risk Assessment for Upland Soils (Operable Unit 3) LCP Chemicals Site, Brunswick, Georgia*
4. *June 2, 2014 Draft Feasibility Study, Operable Unit No. 1 (Estuary), LCP Chemicals Superfund Site, Brunswick, Georgia (Draft)*

Curriculum Vitae

Loren Hopkins Raun, Ph.D.

Senior Environmental Analyst
Bureau of Pollution Control and Prevention
City of Houston Health Department
Houston, TX
e-mail address: Loren.raun@houstontx.gov

Faculty Research Fellow and Lecturer
Department of Statistics
Rice University
Houston, TX 77251-1892
Office Phone: (713) 348-3020
e-mail address: raun@rice.edu

Education

[redacted] Ph.D., Environmental Science and Engineering
Rice University
Thesis research: Statistical Investigation of Air Pollution, Human Exposure Assessment; empirical modeling of ozone monitoring data using 3-D kriging, correlated to personal monitoring and exposure, asthma incidence and decrease in lung function in children and athletes

[redacted] M.S., Environmental Science and Engineering
Rice University
Thesis research: Groundwater Pollution, Stochastic Groundwater Fate and Transport Modeling; developed probabilistic input distributions for groundwater transport parameters for a range of hydrogeologic environments and lithologies and evaluated EPA Land ban model EPACML, (Monte Carlo)

[redacted] B.S., Geophysics
University of Texas, Austin, Texas

Academic Experience

2003-present — Faculty, Rice University, Statistics Department, environmental statistics and human health risk assessment. These are graduate classes in a lecture/project format. The environmental statistics class focuses on using statistical tools to assess current environmental contaminant data. Topics include: sampling decision, distributional assessment, hypothesis testing (parametric and nonparametric), trend analysis and comparison tests to evaluate human health thresholds. The human health risk assessment class focuses on all aspects of environmental contaminant risk assessment and includes exposure and contaminant transport modeling. Positions held: Faculty Fellow (2011 to present), Lecturer (2008-2010 and 1999-2001).

1999	Lecturer, University of Houston, Civil and Environmental Engineer Department, graduate air pollution transport. This is a graduate air pollution transport and modeling class.

Other Research and Work Experience

2014 summer	Visiting Scientist, Centers for Disease Control and Prevention, Atlanta Georgia, Air Pollution and Respiratory Health Branch, Division of Environmental Hazards and Health Effects, National Center for Environmental Health
2010-present	Senior Environmental Analyst, Bureau of Pollution Control and Prevention, City of Houston. Review private landowner groundwater contaminant plume transport potential and human health risk for Municipal Setting Designation City ordinance. Conduct human health assessment of ambient air pollution data in the Houston Region.
2006-2010	Senior Environmental Analyst, Mayor's Office City of Houston Office of Environmental Programming. Focused on statistical evaluation and human health assessment of ambient air toxics in the Houston Region. Major contributor to: City ordinance to control ambient air toxics concentrations; assessed and commented on EPA policy impacting the city (e.g., proposed rule on National Emission Standards for Hazardous Air Pollutants from Petroleum Refineries, air toxic regulation for refineries data collection analysis as impacting Houston, residual risk assessment).
2002 -2005	Air Pollution Researcher, University of Houston, Civil and Environmental Engineering Department, Researcher. Director of air sampling program to support dioxin congener Total Maximum Daily Load (TMDL) project in Houston Region. Sampled ambient and wet and dry deposition flux, evaluated partitioning and developed multiple regression relationships between congeners and meteorological parameters.

2000	Risk Assessment Reviewer, Texas Railroad Commission, Risk Assessment reviewer and co-author of risk assessment guidance for pipeline/oilfield waste including development of default screening levels, dilution attenuation factors, and method for TPH surrogate.
1996 – 1999 (May)	Risk Assessment Regulatory Reviewer, Applied Earth Sciences Consulting, Texas Natural Resource Conservation Commission-LPST Division Risk Assessment Reviewer through a state privatization contract, reviewed more than 200 risk assessments of leaking underground storage tanks including groundwater, soil and air transport.
1999 - 2005	Instructor and Course Author, Applied Environmental Statistics Course (offered through Darcy Environmental), taught all aspects of environmental statistics for risk assessment (including parametric and nonparametric hypothesis testing, trend analysis, normality testing) to professionals in a two day continuing education course at various locations across southern United States several times a year (CEU for Texas Natural Resource Conservation Commission).
1995 - 2000	Risk Assessment Instructor, ASTM Risk-Based Corrective Action Trainer, taught all aspects of risk assessment including toxicology, data assessment, fate and transport to professionals in a three day continuing education course at various locations across the United States.
1989 - 1995	Risk Assessor Statistician and Modeler, (OHM Corporation in Austin, Tx, Jacobs Engineering in St. Louis, Mo and Houston, Tx, Woodward-Clyde Houston, Tx and Applied Earth Sciences, Houston, Tx), risk assessor, environmental modeler and statistician employing groundwater transport (e.g., Modflow, Bioplume/MOC, Domenico), soil vapor transport (Farmer's, Thibideaux-Hwang, Sesoil) and air transport (Box, Gaussian, ISCLT).

Awards and Honors

Eleanor and Mills Bennett Fellowship in Environmental Science, Rice University fellowship awarded to outstanding graduate students, 1996-1997, 1997-1998.

Blackburn Scholarship awarded to fund Environmental Research in Human Health Air Pollution Exposure and Risk Assessment, 1997.

Blackburn Award, Sixth Annual Rice Environmental Conference, for "An Improved Procedure to Estimate Human Exposure-Based Alternative Primary Ambient Ozone Standards," 1998.

National trainer for the ASTM Risk Based Corrective Action Standard, 1996-date.

Designed, Sponsored and Implemented Community Air Pollution Reduction/Awareness Programs:

- Mayor's Keep Houston Beautiful Award, No Mow No More Esplanade Naturalization Program, 2007.
- Governor's Award, Texas Environmental Excellence Award, Condit Elementary School, Condit Kids for Clean Air, 2002
- Mayor's Keep Houston Beautiful Award, Condit Elementary School, Condit Kids for Clean Air, 2002
- National Pollution Prevention Round Table, Most Valuable Pollution Prevention Program, 2002, Condit Elementary School, Condit Kids for Clean Air, 2002
- BP Environmental Excellence Award, Condit Elementary School, Condit Kids for Clean Air, 2002

Major Research Interests

Environmental statistics, human health risk assessment, air, soil and ground water pollution fate and transport.

Submitted Publications

Hoyt, Daniel and Loren H Raun, "Measured and Emission Factor Estimated Benzene and VOC Emissions at a Major US Refinery/Chemical Plant: Comparison and Prioritization," Atmospheric Environment, submitted March, 2015.

Publications

Raun Loren H, Kathy Ensor, Laura A. Campos, and David Persse. "Factors affecting ambulance utilization for asthma attack treatment: understanding where to target interventions," Public Health, March 2015.

Raun Loren H, Katherine B. Ensor, and David Persse. "Using community level strategies to reduce asthma attacks triggered by outdoor air pollution: A case crossover analysis," Environmental Health, August, 2014.

Raun Loren H, Larry Jefferson, and David Persse, Kathy Ensor. "Geospatial analysis for targeting out-of-hospital cardiac arrest intervention." American Journal of Preventive Medicine, Volume 45, Issue 2, August, 2013, pages 137-142.

Ensor, Kathy, Loren Raun, and David Persse. "A case-crossover analysis of out-of-hospital cardiac arrest and air pollution." Circulation. Volume 127, pages 1192-1199, Feb 2013.

Raun, Loren H, Karl Pepple, Daniel Hoyt, Don Richner, Arturo Blanco and Jiao Li. "Community scale air pollution area source impact and public health: Neighborhoods identify an under-regulated area source of metal particulates," Environmental Impact Assessment Review. Volume 41, pages 70-77, January, 2013.

Raun, Loren H., Elena M. Marks, and Katherine B. Ensor, "Detecting improvement in ambient air toxics: An application to ambient benzene measurement in Houston, Texas," Atmospheric Environment, Volume 43 (29), pages 3259-3266. June, 2009.

Correa, Oscar, Loren Raun, Hanadi Rifai, Monica Suarez, Thomas Holsen and Larry Koenig, "Depositional flux of polychlorinated dibenzofurans in an urban setting," Chemosphere, Volume 64 (9), pages 1550-1561, 2006.

Raun, Loren H., Oscar Correa, Hanadi Rifai, Monica Suarez, and Larry Koenig, "Statistical investigation of polychlorinated dibenzo-p-dioxins and dibenzofurans in the ambient air of Houston, Texas," Chemosphere, Volume 60, pages 973-989, 2005.

Correa, Oscar, Hanadi Rifai, Loren Raun, Monica Suarez and Larry Koenig, "Concentrations and Vapor-Particle Partitioning of Polychlorinated Dibenzo-p-dioxins and Dibenzofurans in Ambient Air of Houston, Texas," Atmospheric Environment, Volume 38, Issue 39, pages 6687-6699. December, 2004.

Hopkins, Loren P. A Statistical Investigation of Ozone Exposure Assessment by Direct and Indirect Measurement, Doctoral thesis, Department of Environmental Science and Engineering, Rice University, May, 1998.

Hopkins, Loren P., Katherine Ensor, Matthew P. Fraser, and Hanadi S. Rifai, "Evaluation of the Use of Empirical Ambient Ozone Pollutant Modeling and Subject Activity Logs as an Indirect Measurement of Exposure," Proceedings of the Air and Waste Management Association 91st Annual Meeting, San Diego, California, June, 1998. A&WMA, Paper # 98-MA12.01

Hopkins, Loren P., Katherine B. Ensor and Hanadi S. Rifai, "Empirical Evaluation of Ambient Ozone Interpolation Procedures to Support Exposure Models", Journal of the Air and Waste Management Association, V49, pp. 839-846. 1999

Hopkins, Loren P., Hanadi S. Rifai and Paul LaWare, "Using Compounding Risk as a Guide for Establishing Area-Specific RBCA Risk Limits," Proceedings of the NGWA Petroleum Hydrocarbons and Organic Chemicals in Groundwater: Prevention, Detection and Restoration, November, 1996.

Hopkins, Loren P. and David Bratberg, "Nationwide Survey of Risk Assessment and Risk-Based Corrective Action Procedures," Proceedings of the NGWA Petroleum Hydrocarbons and Organic Chemicals in Groundwater: Prevention, Detection and Restoration, November, 1995.

Bratberg, David and Loren P. Hopkins, "A Comparison of Risk Assessment and Risk-Based Corrective Action Procedures in the United States," Proceedings of the Hazardous Materials Control Resources Institute Superfund XV Conference, Washington, D.C., November 6-8, 1995.

Rifai, Hanadi and Loren P. Hopkins, "The Natural Attenuation Toolbox: A Decision Support System for Evaluating the Appropriateness of Natural Remediation as A Remedial Alternative," Proceedings of the Third Annual Symposium on Bioreclamation, San Diego, Ca., April 1995.

Raparthi, Viru and Loren P. Hopkins, "A Risk Based Evaluation of the Appropriateness of Natural Remediation as a Remedial Alternative in the Vadose Zone," Proceedings of the NGWA Outdoor Action Conference and Exposition on Aquifer Remediation, Ground Water Monitoring, Geophysical Methods, and Soil Treatment, May 2-4, 1995.

Hopkins, Loren P. and Viru Raparthi, "EPA and State Policies on Adjustment of Toxicity Factors for Dermal Absorption," for the Texas Natural Resource Conservation Commission, July, 1994.

Hopkins, Loren P. and Michael F. Marcon, "The Use of Kriging to Optimize Sampling for Risk Assessment and Remediation," Proceedings of the SPE/EPA Environmental Conference 1995.

Durham, Lisa A., Jeff Carman, and Loren P. Hopkins, "Delineation of Hydrostratigraphic Units in a Carbonate Aquifer," Proceedings of the Geological Society of America Meeting, October, 1992.

Hopkins, Loren P. and Scott Edelen, "Optimization of Statistical Hypothesis Testing for Environmental Data Using Nonparametric vs. Parametric Methods," Proceedings of the NGWA Petroleum Hydrocarbons and Organic Chemicals in Groundwater: Prevention, Detection and Restoration, Proceedings, November, 1991.

LaGoy, Peter K., and Loren P. Hopkins, "Practical Considerations in Developing Site Specific Cleanup Levels," Remediation. January, 1991.

Newell, Charles J., Loren P. Hopkins, and Philip B. Bedient. "The HGDB: A New Hydrogeologic Database and Groundwater Modeling Tool," Journal of Ground Water, September-October 1990.

Hopkins, Loren P., Charles J. Newell and Philip B. Bedient, "A Hydrogeologic Database for the EPACML Regulatory Model," Proceedings of the NWWA Petroleum Hydrocarbons and Organic Chemicals in Groundwater: Prevention, Detection and Restoration, November, 1989.

Hopkins, Loren P., A Hydrogeologic Database for Stochastic Groundwater Modeling with Hydrogeologic Specific Applications, Master's thesis, Rice University, Department of Environmental Science and Engineering, May, 1989.

Newell, Charles J., Loren P. Hopkins, and Philip B. Bedient, "Hydrogeologic Database for Ground Water Modeling," American Petroleum Institute, Publication No. 4476, Health and Environmental Sciences Department, February, 1989.

Newell, C. J., J. F. Haasbeek, L. P. Hopkins, S. E. Alder-Schaller, H. S. Rifai, P.B. Bedient, G. A. Gorry, OASIS: Parameter Estimation System for Aquifer Restoration Models. User's Manual Version 2.0, EPA/600/S8-90/039, 1990.

Other Recent Scholarly Works

L. Raun (2013) Fate and Transport Modeling, in *Encyclopedia of Environmetrics*, A.-H. El-Shaarawi and W. Piegorsch (eds), John Wiley & Sons Ltd: Chichester, UK. DOI: 10.1002/9780470057339.vnn073. Published online 1/15/2013.

Raun, L., and Ensor, K. "Association of Out-of-Hospital Cardiac Arrest with Exposure to Fine Particulate and Ozone Ambient Air Pollution from Case-crossover Analysis Results: Are the Standards Protective?" James A. Baker III Institute for Public Policy. Rice University. http://bakerinstitute.org/publications/HPF-pub-RaunEnsorParticulateExposure-101212.pdf

Raun, L. and Hoyt, D., "Measurement and Analysis of Benzene and VOC Emissions in the Houston Ship Channel Area and Selected Surrounding Major Stationary Sources Using DIAL (Differential Absorption Light Detection and Ranging) Technology to Support Ambient HAP Concentrations Reductions in the Community (DIAL Project)," City of Houston Bureau Pollution Control and Prevention, Final Report, June, 2011.

Raun, L., "Severity and Trend Analysis of Benzene and 1,3 Butadiene Concentrations in the ambient Air in the Houston Region: 2000 to 2009," City of Houston Bureau of Air Quality Control.

Raun, L., "Trend Analysis of Ozone Concentrations in the City of Houston and Vicinity (2005-2009)," City of Houston Bureau of Air Quality Control.

Raun, L., "Statistical Assessment of Benzene and 1,3 Butadiene in Ambient Air in the Houston Region: 1997 to 2007," City of Houston Mayor's Office of Environmental Programming. http://www.greenhoustontx.gov/reports/benzeneandbutadiene.pdf

Comments of the City of Houston: TCEQ 1,3 butadiene proposed ESL changes. http://www.greenhoustontx.gov/reports/butadiene20080711.pdf

City of Houston Benzene Action Plan, An Interim Report—May 27, 2008 http://www.greenhoustontx.gov/reports/benzeneactionplan-2008may.pdf

Comments of the City of Houston: "National Emission Standards for Hazardous Air Pollutants from Petroleum Refineries," EPA proposed rule, December 20, 2007.

"Houston Regional Benzene Air Pollution Reduction: A Voluntary Plan for Major Sources," City of Houston Mayor's Office of Environmental Programming, Department of Health and Human Services, Bureau of Air Quality Control, major author. 2006. Using results from the TRI, in conjunction with EPA's RSIE and NATA models, the major potential air toxic emitters posing the highest risk to Houstonians were identified. The ambient air toxic data from monitors up and downwind of these facilities were assessed. Statistically significant differences between air contaminant distributions were noted and established as baseline conditions. Facility and process specific emission reduction mechanism recommendations were made. Facilities entering the voluntary agreement would implement emission reduction mechanisms beyond those currently required by regulation. Subsequent reductions in air concentrations from the baseline condition would be tracked. http://www.greenhoustontx.gov/reports/benzenereductionplan.pdf

City of Houston Code of Ordinances, Draft Nuisance Ordinance; Drafted amendment to the nuisance ordinance to specifically address ambient air concentrations of certain hazardous air pollutants.

Current or Recent Board/Committee Participation

Houston Wilderness Board, 2014 to present.
EPA Science Advisory Board, Risk and Technology Review Methods Panel, 2009
Houston Region Air Quality Task Force, 2007
Houston Exposure to Air Toxics Study Advisory Committee, 2007 to 2009

Recent Multiple Reviews or Significant Edits

State of Health, Houston/Harris County, Texas, 2008, 2009, 2010, 2011. Houston Department of Health and Human Services.

Counting on Quality of Life: An Environment Indicator Report, December 2007, Center for Houston's Future.

Comparative Assessment of Air Pollution-Related Health Risks in Houston, Ken Sexton, Stephen H. Linder, Dritano Marko, Heidi Bethel and Philip J. Lupo, doi: 10.1289/ehp.10043, July 5, 2007, online.

The Control of Air Toxics: Toxicology Motivation and Houston Implications, A. Clements, V. Flatt, M. Fraser, W. Hamilton, P. Ledvina, S. Mathur, A. Tamhane, and J. Ward, Rice University, 2007

A Closer Look at Air Pollution in Houston: Identifying Priority Health Risks, Report of the Mayor's Task Force on the Health Effects of Air Pollution, convened by the Institute for Health Policy, The University of Texas School of Public Health under the auspices of The University of Texas Health Science Center at Houston and the City of Houston, Institute for Health Policy Report ES-001-006.

Recent Presentations

Raun, L., Richner, D. "Study of the Accuracy of Emission Factors and Emission Estimating Methods Using the DIAL System. What does DIAL tell us about benzene and VOC emissions from refineries?" EPA webinar presented. October 2012.

Raun, Loren, "What is actually emitted from Area Sources: Results of a Special Study of Metals Recyclers," EPA National Air Quality Conference - Ambient Monitoring 2012, Assessment and Special Studies, Denver, CO, May, 16,2012

Raun, Loren, "Differential Absorption Light Detection and Ranging Measured Emissions at a Houston Ship Channel Area Petroleum Refinery and Chemical Plant: Methods, Results, Comparison to Emission Factors," Southeast Texas Photochemical Modeling Technical Committee, Texas Commission of Environmental Quality, October 19, 2011.

Raun, L., K. Ensor and D. Persse, "Out of hospital cardiac arrest based on the levels of ozone and fine particulates: tracking and predicting at a temporal scale of one hour and a continuous spatial scale, " Center for Disease Control, Tracking in Action, 2011 National Conference, Atlanta, Georgia, September 14, 2011.

Raun, L., K. Ensor and D. Persse, "Out of hospital cardiac arrest based on the levels of ozone and fine particulates: tracking and predicting at a temporal scale of one hour and a continuous spatial scale, " University of Texas School of Public Health, Houston, Biostatistics Department, Texas September 20, 2011.

Raun, L., Rice Environmental Conference, Houston Air Policy: Compliance, Impact, Limitations, October, 2008.

Raun, L., Rice Air Exchange Meeting, the State of Houston Air and the Voluntary Plan, November, 2007.

Raun, L., Rice Environmental Conference, Houston's Proposed Regional Benzene Air Pollution Reduction: A Voluntary Plan for Major Sources, October 16, 2007.

Raun, L., and A. Blanco, Statistical Techniques to Gain More Information from the Same Set of Air Monitoring Data: A Better Understanding of the Air Pollution Human Health Risk in Houston, U. S. EPA Region 6 16th Annual Quality Assurance Conference, October 20-24, Dallas, Texas 2006.

Raun, L., O. Correa, H.S. Rifai, M, P. Suarez and L. Koenig, Dioxin in Air, U. S. EPA Region 6 13th Annual Quality Assurance Conference, October 20-24, Dallas, Texas 2003.

Pepple, Karl, Brian Yeoman, Loren Raun, Daewon Byun, "Evaluation of Campus Commitments to Sustainability Indicators in DOE Humid Zones," poster presented November 2008.

Raun, L., and Jonathan Ward, "Clearing the Air in Houston: Using Science to Address Policy," Public Health, Washington D.C. November, 2007.

Raun, L., "Houston's Proposed Regional Benzene Air Pollution Reduction: A Voluntary Plan for Major Sources," presented multiple times, City of Houston Environmental Committee, City of Houston Public Hearing, February 12, 2007, Council of Local Mayors, March, 14 2007; Houston Bar Association, Environmental Law Section, Greater Houston Partnership, Informational Public Meeting, Rice University, February 22, 2007.

Raun, L., "Methodology for Tracking the Health of an Airshed: Ambient Benzene and 1,3 Butadiene in Houston Air 1997 to 2007," presented multiple times, City of Houston Bureau of Air Quality Control, Mayor's Office of Environmental Programming.

Raun, L., "Houston Air Monitor Location Sampling Optimization: Benzene, 1, 3 Butadiene and Ozone," 2007 City of Houston Bureau of Air Quality Control

Raun, L., Dan Hoyt and Arturo Blanco, "A Quantitative decision-based voluntary benzene reduction plan for ambient air in the Houston region," EPA Conference, Las Vegas, October 2006.

Raun, L. "Houston Human Health Risk from Air Pathway: Contribution form Shell Oil," City of Houston Bureau of Air Quality Control, April 24, 2006.

Rifai, H.S., and L. Hopkins, The Natural Attenuation Toolbox: A Decision Support System for Evaluating Natural Attenuation, NGWA/AP Conference on Petroleum Hydrocarbons and Organic Chemicals in Ground Water: Detection, Prevention and Restoration, Houston, TX. November 29-December 1, 1995 (Poster Presentation).

Rifai, H. S. and L. Hopkins, An Exposure/Rick Based Screening Approach for Selecting the Natural Attenuation Alternative at Sites, In Situ and On-Site Bioreclamation, The Third International Symposium, San Diego, CA, Apr 24-27, 1995 (Poster Presentation).

Memberships

Air and Waste Management Association
American Association for the Advancement of Science
American Heart Association
Houston Wilderness, Member of the Board
International Society of Environmental Epidemiology
Society of Public Health Educators

Current Funding

Houston Endowment- "Phase II- The impact of air pollution on the incidence of asthma attacks in Houston"
NIH- "Sustainable Solutions to Metal Air Pollution in Disadvantaged Neighborhoods"

Environmental Stewardship Concepts, LLC

March 16, 2015

Comments on:
LCP Chemicals Site Proposed Plan
prepared by
Environmental Stewardship Concepts, LLC
on behalf of
Glynn Environmental Coalition

Questions for EPA:
Based on comments and questions from the community and detailed review of the Proposed Plan, Human Health Risk Assessment and Baseline Ecological Risk Assessment, and in consultation with the Glynn Environmental Coalition, ESC, LLC has not been able to successfully determine the correct answer to a number of questions. Therefore, we submit the following questions to EPA:

1) What sampling will be undertaken to determine the full extent of contamination in the Turtle River estuary system as a result of the LCP facility activities? This question is based on the data showing Aroclor 1268 congener profiles on Sapelo Island sediments, human tissues and in dolphins from the Turtle River.

2) How will EPA incorporate new methods for cleaning up contaminated sediments that have not been considered in the FS?

3) What corrections will EPA make to the Human Health Risk Assessment to account for the errors and omissions in human exposures and toxicity of contaminants, considering that site use is greater than estimated, fish consumption is greater than the value used and that dioxin contribution has not been included in the toxicity of site contaminants?

4) How does the Proposed Plan address the contamination of dolphins and other marine life that are not now included in the BERA or in another aspect of the RI/FS?

5) What additional sampling or analysis will EPA conduct in order to account for the omission of fate and transport of PCBs and other contaminants by *Spartina* grasses?

6) Will EPA require ecological risk evaluation of dolphins, based on all mammalian data, such as mink and other marine mammals and evaluate the toxicity to mink and river otter on the effects (toxicity) of PCBs as congeners?

7) The toxicity evaluations of the sediment have not adequately captured the anticipated toxicity, thus, how will EPA re-evaluate the sediment toxicity to account for this information?

8) Will EPA require measurement and assessment of dioxin in the site contaminants, EPA having included reference to the cleanup at Lake Onandoga that has both PCBs and dioxins, and obviously admits the occurrence of dioxins in this type of site.

9) Will EPA require alteration of the assessment of damage to the marsh to account for the factual errors present in the statements of damage to the marsh based on out-dated methods that are not used in working in salt marshes?

10) What provisions in the Record of Decision will EPA make for the consequences of rising sea-level and climate change on the remedy and the site?

Table of Contents

Introduction

Environmental Stewardship Concepts, LLC is submitting comments on the LCP Chemicals Site Proposed Plan on behalf of Glynn Environmental Coalition. We cover specific comments on the Proposed Plan report, as well as several areas of concern including institutional controls, fish consumption, site boundaries, new technologies, and a literature review of PCB toxicity.

Specific LCP Chemical Site OU1 Proposed Plan Comments

Several items in the LCP OU1 Proposed Plan raise concerns that threaten the goal of a cleanup that will protect human and environmental health.

- There needs to be more sediment removal, compared to capping and thin-cover placement, because sediment removal is a more effective and permanent cleanup option.
- A re-planting program of *Spartina* post-remediation should be one of the first monitoring efforts to help speed up ecosystem recovery.
- The evaluation of the way the LCP site is used by community members is inaccurate, specifically seen in the fish consumption rates used in the risk assessment that set the basis for achieving specific cleanup goals.
- Atlantic bottlenose dolphins are an essential part of the local ecosystem and are not included in the ecological risk assessment for the site.

- Thin-cover placement, or enhanced natural recovery, is not a sustainable recovery method.
- The Human Health Risk Assessment does not accurately assess human health risks because fish consumption values are wrong, and because dioxins and furans are not included in the exposure toxicity assessment.
- *Spartina* accumulates PCBs, but this fact is not considered in the estimates of PCB contamination or fate and transport.

These specific issues are each discussed further below.

Sediment Removal vs. Capping
Capping and thin-cover placement have been proposed as cleanup methods for large sections of the site. However, both of these methods cover up, rather than clean up, the contaminants of concern. Sediment removal is a viable option for the LCP site and should be implemented on a larger scale.

While the Proposed Plan claims that thin-cover placement is a well-studied method for site cleanup, there are not enough documented success stories of using thin-layer caps at contaminated sites to say that this remediation method is well-studied. Many of the examples of thin-layer capping for sediment remediation found in the LCP Feasibility Study are not salt marshes but bays, harbors or other large waterways like rivers (USEPA 2014). These are all environments with greater water depths and different hydrology than a typical salt water marsh. Thus, the thin-layer capping sediment remediation examples in the Proposed Plan are not very relevant to the LCP site.

Furthermore, thin-cover placement is not a sustainable recovery method. By nature, the layer of sediment will be thin, six inches or less, and will not be adequate to contain any contaminants in the marsh bed. A thin-cover layer is easily disturbed. For example, a storm surge could easily move the sediment around, as could scour from a passing boat. In addition, animals living in the marsh like crabs and worms will burrow into sediment and disturb the layer, causing bioturbation of the cap.

As larger storms and hurricanes occur more often due to climate change, there will be an increased chance that the contaminated sediments at this site will be disturbed and that neither thin-cover placement nor capping will be protective. Armoring of a wetland cap is not affective as the tidal flow will simply redirect, carrying sediment with it.

Salt Marsh Grasses
The RI, FS and Proposed Plan make two substantial and fundamental omissions with regard to *Spartina* grasses in the estuary and on the LCP site. The first omission is failure to take into account the fact that *Spartina* does take up contaminants, and the site of accumulation may be any and all parts of the plant, including the rhizome, roots, stalk or stem, and leaf. The failure to account for these processes of uptake and accumulation means that contaminants contained in the living medium are not accounted in the estimate of total contamination on site. The second consequence is that the fate and transport of contaminants left on site under the Fs options and in the

Proposed Plan do not include the movement of contaminants via *Spartina* in the marsh. Both of these components of fate and transport of PCBs are potentially significant pathways and compartments for contaminants. The RI and FS really need to be redrafted to include *Spartina*.

The cleanup process for the marshes of the LCP site will involve the removal of native marsh vegetation, which is essential for the health of the ecosystem. The Proposed Plan relies heavily on the assumption that marsh plants will re-grow on their own within two years. However, the Plan must include a re-planting program in order to speed up recovery of the ecosystem post-remediation. Native *Spartina* will attract native wildlife, which will in turn help the ecosystem return to a pre-remediation state. Replanting Spartina has been conducted for many decades and there is substantial expertise on the practice, in both the private and public sectors (U.S. Fish and Wildlife, NOAA and US Army Corps of Engineers.

Estuary Use by People

The Proposed Plan states that the estuary is rarely used for recreation because it is too difficult to navigate with a small boat, and therefore the impacts of cleanup on that area do not need to be considered. However, there are no data outside the Purvis Creek area to show that the waterways of the estuary are used infrequently. Community surveys must be completed before the Plan can conclude that community members are not using this area for fishing or recreation. The lack of information is not data in support of the negative. Personal observation by ESC, by GEC and accounts from community members contradict the statement of lack of use, which must be considered anecdotal and of questionable value.

Dolphins

Atlantic bottlenose dolphins, which inhabit the Turtle/Brunswick estuary and coastal waters, are apex predators in the southeast. Because they are at the top of the food chain, dolphins bioaccumulate more toxins in their bodies than the animals lower in the food chain. Studies have shown that concentrations of PCBs in Brunswick dolphins are ten times higher than the PCB concentrations in dolphins found in the Savannah area, and the resident dolphins of Brunswick have the highest reported PCBs levels of any marine mammal in the world (Balmer et al. 2011). Dolphins across multiple generations have already been harmed by PCBs, suffering from anemia, reduced hormone levels, and increased susceptibility to disease (Schwacke et al. 2012). Dolphins play an important role in the Brunswick ecosystem and should be a central consideration in the Proposed Plan.

Human Health and Ecological Risk Assessments

The Human Health Risk Assessment in the Proposed Plan does not adequately account for the risks to human health posed by the contaminants at the estuary site. According to the risk assessment, the two chemicals causing the most harm are mercury and Aroclor 1268. There is no consideration of dioxin as a toxic chemical at the site, despite the fact that dioxin is a known contaminant of the industrial process at LCP (chlor-alkali). The reductions necessary to meet fish/shellfish goals to eventually end consumption advisories "are likely to be observed only after several years post remediation," delaying the health-protective measures of this remediation.

The Proposed Plan defines a high quantity fish consumer as an adult who eats 40 fish meals per year for 30 years, and a recreational fish consumer as someone who eats 26 fish meals per year for 30 years. The difference between the two consumer categories is small and the fish consumption numbers should be increased based on detailed surveys of local fishermen. The data on local fish consumption in the Brunswick area could have been obtained via surveys, but was not. In fact, ATSDR has a better data set from a nearby community and ATSDR recommended using that data, which would have substantially increased the consumption rates used in the HHRA. The result would have been a conclusion to reduce site risks by more contaminant removal or treatment.

In the Ecological Risk Assessment, one of the sites used to compare the levels of chemicals in the sediment at LCP is only four miles from the LCP site at Troup Creek, and has shown to be contaminated with the same chemicals. Another reference site with a history of cleaner sediments should be used instead. Very little constructive comparison can be made when using an equally contaminated reference site.

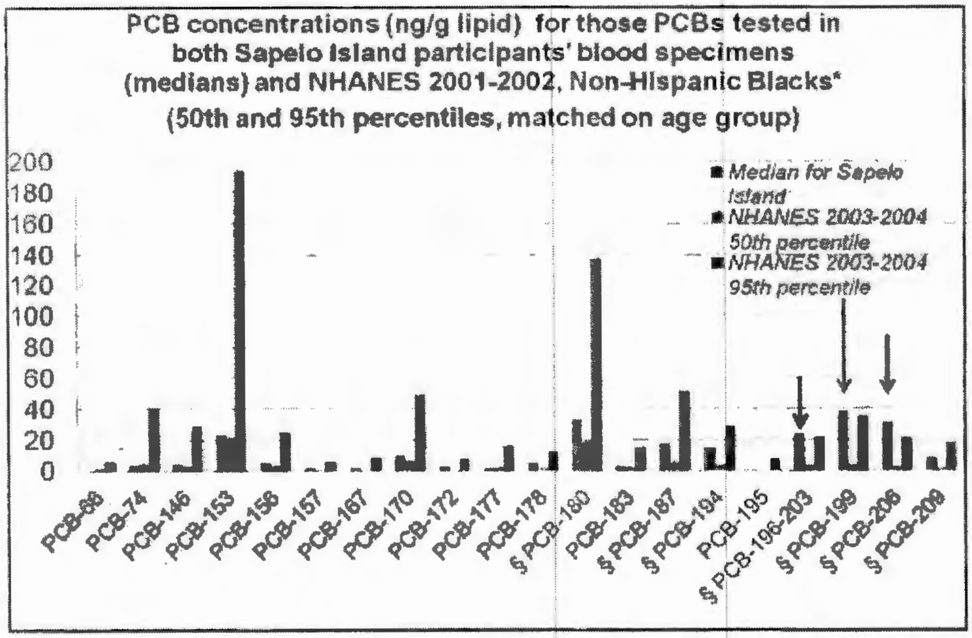
Additionally, not all of the individual stations, domains, and creeks meet the acceptable PRG risk ranges; they are only protective of the local ecosystem when creeks and/or domains are considered collectively. This averaging across spatial data dilutes the exposure possible at each area of contamination. Further, the proposed cleanup levels were determined to be adequate, despite areas "Where CULs may not be achieved and residual risks in some areas may occur" because they existed "in combination with a robust monitoring program"; a monitoring program should not be considered "robust" when monitoring only occurs every five years with an undefined set of "triggers" for additional actions.

Total Acreage of Cleanup
To clean up the marsh to a level protective of human and environmental health, 81 acres of marsh would need to be cleaned up. However, the chosen cleanup plan will only clean up 24 acres of marsh, leaving behind 57 acres with high levels of mercury and PCBs.

Sapelo Island
Sapelo Island is a state-protected barrier island north of Brunswick. The Agency for Toxic Substances and Disease Registry (ATSDR) recently conducted a study that showed that residents of Sapelo Island have dangerously high levels of PCBs in their bodies, based on their blood samples. Scientists conducting the study sampled nine residents, ages 21-74. All the residents stated that they ate two to three meals of locally-caught seafood per week, and had eaten locally-caught seafood for over five years.

When the results of the blood tests were compared to samples from non-Hispanic African Americans throughout the country, some of the PCB levels in blood of the

Sapelo Island residents were above the 95th percentile. In addition, when the Sapelo residents' samples were compared to the samples from local Atlantic bottlenose dolphins, scientists found that the human and dolphin samples contained similar environmental contaminants. This shows that contaminants from the LCP Chemicals Site have migrated into the waters and sediment surrounding Sapelo Island, into the local seafood, and finally, into the bodies of local residents who eat the local seafood.



The red bars are the median sample for the Sapelo Island residents. The three samples with the arrows above them point to Sapelo Island blood samples that were above the 95th percentile for PCB levels in blood (Backer and Mellard 2014).

References

Balmer, B. C., Schwacke, L. H., Wells, R. S., George, R. C.,Hoguet, J., Kucklick, J. R., Lane, S. M., Martinez, A.,McLellan, W. A., Rosel, P. E., Rowles, T. K., Sparks, K., Speakman, T., Zolman, E. S., & Pabst, D. A. 2011. "Relationship between persistent organic pollutants (POPs) and ranging patterns in common bottlenose dolphins (Tursiops truncatus) from coastal Georgia, USA." *Science of the Total Environment,* 409(11), 2094-2101.

Backer, Lorraine C., Mellard, David. September 3, 2014. Polychlorinated Biphenyls (PCBs) in Georgia Coastal Environments and Populations. [Powerpoint slides]. http://www.glynnenvironmental.org/images/stories/pdf/NCEH-ATSDR-LCP-Sapelo-Isl9-3-14.pdf

Schwacke, Lori H., Eric S. Zolman, Brian C. Balmer, Sylvain De Guise, R. C. George, Jennifer Hoguet, Aleta A. Hohn, et al. 2012. Anaemia, hypothyroidism and immune suppression associated with polychlorinated biphenyl exposure in bottlenose dolphins (tursiops truncatus). *Proceedings.Biological Sciences / the Royal Society* 279 (1726): 48.

U.S. Environmental Protection Agency (b), Region 4. June 2, 2014. Feasibility Study: LCP Chemicals Superfund Site Operable Unit No. 1 (Estuary).

Institutional Controls at the Site

Institutional controls are a group of actions that seek to limit human activity to decrease exposure to a contaminated ecosystem. The EPA defines institutional controls as "...administrative and legal controls, that help minimize the potential for human exposure to contamination and/or protect the integrity of the remedy" (USEPA 2014a). Common examples of institutional controls (ICs) include fish consumption advisories, land use designations, and zoning restrictions. The EPA's Proposed Plan for the LCP Chemicals Superfund Site relies heavily on ICs in the form of fish consumption advisories and permit requirements. Currently, fish consumption advisories are in effect for Purvis Creek and the Turtle River, and a commercial fishing ban was issued for Purvis Creek. Permits are required for any in-water construction activities for Operable Unit 1 of the site (USEPA 2014b).

To estimate risk at the LCP Chemicals Superfund site, the EPA used Baseline Risk Assessments (BRAs) found in the Remedial Investigation/Feasibility Study. A Baseline Human Health Risk Assessment (BHHRA) and a Baseline Ecological Risk Assessment (BERA) were conducted for the site. The BHHRA provided the cancer and non-cancer risks associated with consuming fish and shellfish from the site, and the BERA provided the estimated likelihood of adverse ecological effects at the site. While the EPA clearly outlined how risk reduction was estimated in the BRAs, any risk reductions that result directly from the use of ICs are not made clear. Thus, based on the information given in the Proposed Plan and Feasibility Study, it is not possible to determine the actual risk reduction resulting from the use of ICs.

Issues with Institutional Controls

While ICs are meant to protect human health, they are simply a means of removing an exposure pathway by restricting human activity. The Proposed Plan for the LCP Chemicals site states that ICs will address residual risks posed by any un-remediated contaminants, and that ICs "help ensure the remedy's long-term structural integrity and effectiveness in reducing COC concentrations in fish/shellfish..." (USEPA 2014c 40). Yet ICs do nothing to reduce contamination; they simply keep people away from contaminated media at a site. Studies and government reports have found significant flaws in the philosophy and implementation of institutional controls, specifically with fish consumption advisories.

In 2005, the U.S. Government Accountability Office published a report titled "Improved Effectiveness of Controls at Sites Could Better Protect the Public." The study analyzed the implementation and effectiveness of institutional controls at Superfund and RCRA sites throughout the U.S. The researchers found that while the use of ICs has increased over time, there are numerous problems with both the implementation and the organization of ICs. One of the most obvious issues is one of timing and accountability. The GAO found that often documentation did not adequately address when the ICs should be implemented, how long implementation should last, or who would be responsible for enforcement. This led to ICs not being implemented until after cleanup processes were finished, posing significant risks to local residents. The GAO also found issues with the process for implementation of ICs. Language in the IC documentation was often vague, and the EPA sometimes failed to identify the specific mechanism for each IC. The GAO pointed out that in creating ICs, the EPA needs to identify the parties responsible for enforcing the ICs, such as state governments or site owners (2005). Because of the faulty implementation and enforcement of ICs, ICs come across as recommendations, and are thus taken much less seriously.

Results of a recent study of people living on Sapelo Island, a barrier island 25 miles northeast of Brunswick, showed that residents have dangerously high levels of PCBs in their bodies due to the consumption of locally-caught seafood (Backer and Mellard 2014). The study, which was conducted by the Agency for Toxic Substances and Disease Registry, examined blood levels from adults who had lived on Sapelo Island for at least five years, and who consumed at least two meals of locally-caught seafood each week. The researchers found that 44% of the sampled residents were unaware of Georgia's fish consumption advisories. Out of the five residents who were asked if they changed their fish consumption habits after learning of the advisories, only two responded that they had. If this small sample size is representative of the population in and around Brunswick, then the majority of residents who practice subsistence fishing are continuing to consume the contaminated fish that the consumption advisories warn against. Many scientific studies on fish consumption advisories, such as the two studies mentioned below, provide similar results to the Sapelo Island study: fish consumption advisories are often ignored or simply interpreted as recommendations.

In a study on the effectiveness of fish consumption advisories, researchers found that fish consumption advisories are unlikely to be effective in reducing the exposure of infants and children to persistent organic pollutants that have long elimination rates in the human metabolic system (Binnington et al. 2014). Persistent organic pollutants like PCBs have long elimination half-lives, meaning that the human metabolic system takes longer to break down persistent pollutants like PCBs than non-persistent pollutants. For this study, scientists used a mechanistic model to estimate and compare prenatal, postnatal, and childhood exposure to PCB-153 under different scenarios of maternal guideline adherence to fish consumption advisories. The scientists assumed realistic time periods for advisory compliance for mothers (from one year to five years before birth), and found that temporarily eliminating or reducing maternal fish consumption for fish contaminated with persistent organic pollutants did very little to reduce the exposure of infants and children to PCBs (Binnington et al. 2014). This study shows that it is not just the contaminated fish that prove problematic; it is the environmental persistence of the contaminants inside the human body, which can take years to be eliminated.

In a 2008 study concerning public knowledge about fish consumption advisories, Burger and Gochfeld found that many subjects questioned in a general university population could not give any specific answers to questions regarding the existence of fish consumption advisories. Of the respondents, 62% could not give any specific information as to why fish consumption warnings exist. Over half of the respondents did not know which fish are high or low in contaminants, and 16% of the subjects could not provide an answer as to why eating fish can be healthy. The authors point out that government agencies are often concerned that the public will be confused by advisory details, and that information on the nature of risks and benefits of fish consumption can be too complicated to convey. The authors believe that operating based upon that assumption is a mistake. They state that the lack of such information is a major part of ineffective communication. The study concluded that public agencies must provide more directed messages regarding the basis for making risk decisions (Burger and Gochfeld 2008).

The results of the Burger and Gochfeld study on public knowledge of fish consumption advisories were echoed by the Sapelo Island study, where residents continue to consume locally caught seafood even after learning of the risks posed by eating contaminated fish. The problem with relying on fish consumption advisories and other ICs for the LCP Chemicals site is two-fold. Half of the problem is that ICs do nothing to reduce contamination; they are simply a means of controlling human activity. The other part of the problem is that fish consumption advisories are, and will continue to be, an ineffective way to protect human and ecological health. Many residents are unaware of the fish consumption advisories, and many of those that are aware of the advisories choose to ignore the regulations and continue eating contaminated seafood. The LCP Chemicals Proposed Plan needs to be amended to rely on a more comprehensive removal of contaminants, not on institutional controls that attempt to keep humans away from their local waterways.

References

Backer, Lorraine C., Mellard, David. September 3, 2014. Polychlorinated Biphenyls (PCBs) in Georgia Coastal Environments and Populations. [Powerpoint slides].

Binnington, M. J., Quinn, C. L., Mclachlan, M. S., & Wania, F. (2014). Research | Children ' s Health Evaluating the Effectiveness of Fish Consumption Advisories : Modeling Prenatal , Postnatal , and Childhood Exposures to Persistent Organic Pollutants, (2), 178–186.

Burger, J., & Gochfeld, M. (2008). Knowledge about fish consumption advisories: a risk communication failure within a university population. *The Science of the Total Environment*, *390*(2-3), 346–54. doi:10.1016/j.scitotenv.2007.10.016

U.S. Environmental Protection Agency (a). "Institutional Controls (ICs)." Accessed 30 December, 2014. http://www.epa.gov/oerrpage/superfund/policy/ic/index.htm.

U.S. Environmental Protection Agency (b), Region 4. June 2, 2014. Feasibility Study: LCP Chemicals Superfund Site Operable Unit No. 1 (Estuary).

U.S. Environmental Protection Agency (c), Region 4. November 2014. Superfund Proposed Plan: LCP Chemicals Superfund Site Operable Unit 1.

U.S. Government Accountability Office. January 2005. Hazardous Waste Sites: Improved Effectiveness of Controls at Sites Could Better Protect the Public. GAO-05-163.

Fish Consumption Advisories at the Site

At the LCP Chemicals Superfund Site, fish consumption advisories are in effect for Purvis Creek and the Turtle River, and a commercial fishing ban was issued for Purvis Creek. Permits are required for any in-water construction activities for Operable Unit 1 of the site (USEPA 2014a). However, the fish consumption advisories described in the Proposed Plan are insufficient for the protection of human health. The Proposed Plan relies on fish consumption information that is outdated and fails to gather appropriate data on local African-American residents' fishing habits and fish consumption rates. The fish consumption information for the local community, as outlined in the health risk assessment and carried forward in the Proposed Plan, must be fully revised in order to protect human health.

The Problems

The issues with fish consumption advisories are not unique to this site; government reports and scientific studies have found numerous problems with implementation and community adherence to fish consumption advisories. For example, a 2011 survey by the EPA found that fish advisories are not legally enforced in all states. The survey reported that 49 U.S. states and Native American tribes do not legally enforce advisories or bans, and only seven do. This same survey documented 17 out of 18 states that include consumption information for sport and subsistence fishers in their commercial fishing ban information (USEPA 2011). Other inconsistencies at the state level include differences in the ways sampling is conducted and differences in the number of contaminated fish required to affect an advisory. For example, four states in the survey required only one individual fish sample exceeding human health criteria to issue an advisory while others, such as Virginia, required between 11 to 20 fish. Additionally, some states require multiple years of sampling before an advisory can be issued, even after contaminant levels in fish tissue have exceeded state criteria (USEPA 2011).

At the LCP site, the fish consumption advisories proposed by the EPA do not protect human health, nor do they accurately reflect the demographic makeup of the local population. The advisories are based upon a 1999 study conducted by the Glynn County Health Department (GCHD), comparing 211 residents who may have been exposed to mercury through wild game and seafood consumption from the Turtle River (target group participants) to 105 residents who reported they had not consumed seafood or wild game from that area (comparison group participants). Overall, 101 target group participants identified themselves as either recreational, commercial, or subsistence fishers; 96% of these individuals reported themselves as recreational fishers, 3% identified themselves as commercial fishers, and only 1% identified themselves as subsistence fishers (USDHHS/ATSDR 2014). However, the African-American community is severely underrepresented in the target study group. African-Americans made up only 4% of the people surveyed, yet according the 2010 U.S. census, African-Americans make up 26% of the Glynn County population, and nearly 40% of the population within four miles of the LCP site (USDHHS/ATSDR 2014). Thus, the ATSDR confirms that the GCHD study is not an accurate representation of commercial or subsistence fishers living in the area (2014).

Other shortcomings of the GCHD study include the possibility that participants purposely restricted their intake of fish following the dietary recall survey, leading to inaccurate urine mercury results (USDHHS/ATSDR 2014). Furthermore, in a study of fishers living along the nearby Savannah River, Burger et al. found that, on average, African-Americans eat more fish meals per month than whites, eat slightly larger portions of fish than whites, and therefore eat higher amounts overall of fish per month than whites (1999). The ATSDR states that it is reasonable to assume that African-Americans living in Brunswick have similar eating habits to those living along the Savannah River, and so the report explicitly states, "The results of the Brunswick fish study should not be applied to African-Americans in the Brunswick area [. . .]" (2014, pp.8).

Lastly, sensitive groups including children, women of childbearing age, and the elderly reside within a one-mile radius of the site. The ATSDR reports that based on a 2010 U.S. census, approximately 4,202 people live within a one mile radius of the LCP site; among these, nearly 451 are children aged 6 or younger, 519 are adults who are at least 65 years of age, and 827 are women of childbearing age (2014). Although 37% of target group participants were 60 or older, only 6% of participants were under the age of 10 years old (GCHD 1999).

In light of the major problems with the fish consumption advisories at the LCP site and the data that the advisories are based upon, it is essential to enforce stricter and more accurate fish consumption advisories. It will be many years until local fish and shellfish are clean enough for human consumption, and as such all advisories should be maximally protective of human health. Below we describe the ways in which new fish consumption advisories should be implemented.

The Solution

The fish consumption advisories in the LCP Chemicals Proposed Plan need to be based on data from a more accurate source. The data collected from local residents should accurately represent the population. This means that the data should reflect that African-Americans make up 26% of the Glynn County population (USDHHS/ATSDR 2014). This type of data collection could be done through an environmental justice analysis. An environmental justice analysis recognizes that some populations experience higher levels of risk than others. According to Executive Order 12898, an environmental justice analysis "directs federal agencies to identify and address disproportionately high adverse human health or environmental effects on minority and low-income populations that may result from their programs, policies, or activities" (USEPA 2014b, pp.1). An environmental justice analysis would account for the higher levels of risk experienced by residents who practice subsistence fishing, and therefore help to create guidance for more protective fish consumption advisories.

References

Backer, Lorraine C., Mellard, David. September 3, 2014. Polychlorinated Biphenyls (PCBs) in Georgia Coastal Environments and Populations. [Powerpoint slides]. http://www.glynnenvironmental.org/images/stories/pdf/NCEH-ATSDR-LCP-Sapelo-Isl9-3-14.pdf

Burger, Joanna, Warren Stephens, L. Boring, C. Kuklinski, Shane Gibbons, and Michelle Gochfeld. 1999. "Factors in Exposure Assessment: Ethnic and Socioeconomic Differences in Fishing and Consumption of Fish Caught along the Savannah River." *Risk Analysis* 19, no. 3: 427-38.

Glynn County Health Department. 1999 July. "Consumption of seafood and wildgame contaminated with mercury, Brunswick, Glynn County, Georgia (Final Report)." Atlanta: US Department of Health and Human Services, Public Health Service, Agency for Toxic Substances and Disease Registry.

U.S. Department of Health and Human Services, Public Health Service, Agency for Toxic Substances and Disease Registry, Division of Community Health Investigations. 2014. "Public Health Assessment, LCP Chemicals Superfund site and Adjacent Areas." Brunswick, Georgia, EPA Facility ID: GAD099303182.

U.S. Environmental Protection Agency. 2011. "Summary of Responses to the 2010 National Survey of Fish Advisory Programs." EPA-820-R-12-001.

U.S. Environmental Protection Agency, Region 4. 2014a. "Superfund Proposed Plan: LCP Chemicals Superfund Site Operable Unit 1."

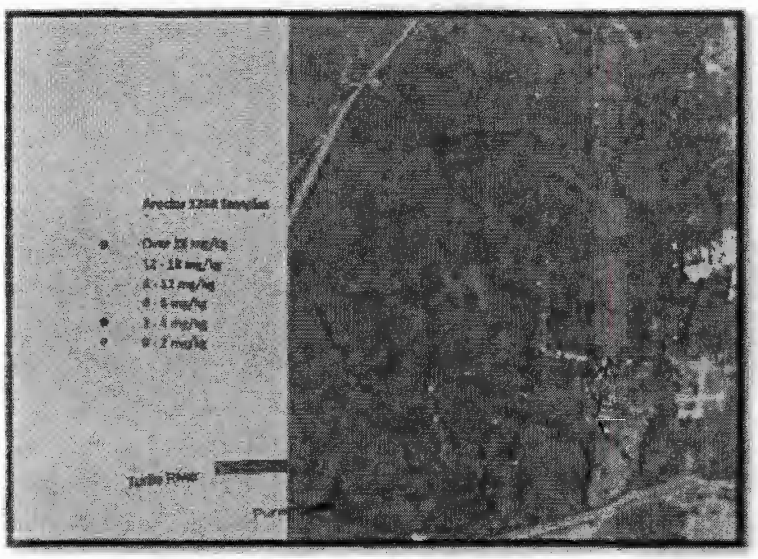
U.S. Environmental Protection Agency. 2014b. "Environmental Justice Analysis." Accessed 22 January, 2015. http://www.epa.gov/sustainability/analytics/environmental-justice.htm

Site Boundaries at the Site

Site boundaries are established by the EPA as part of the Superfund process once the area of contamination has been determined. Boundaries delineate the area within which cleanup processes will occur and contamination will be contained. EPA further divides cleanup processes into operable units (OUs), which are "each of a number of separate activities undertaken as part of a Superfund site cleanup" (EPA 2013). The LCP Chemicals Superfund site is divided into three operable units (OUs) in order to address the differing types of contamination at the site. Following an EPA revision in 2005, Operable Unit 1 represents the marsh, Operable Unit 2 represents groundwater, and Operable Unit 3 represents dry-land soils (USDHHS/ATSDR 2014). The U.S. DHHS/ATSDR report (2014) states, "Other OUs may be examined when data are available for review" (pp.3). Sufficient data are available to question the currently designated site boundaries, conduct additional sampling, and add additional OUs.

The Problems

There are a number of problems with EPA's currently designated LCP Chemical's site boundaries. First, the boundaries are inaccurate. The EPA failed to include available data on the continued migration of Aroclor 1268 in its analysis of site boundaries. According to EPA's *Clarifying the Definition of 'Site' Under the National Priorities List*, "a 'site' is best defined as that portion of a facility that includes the location of a release (or releases) of hazardous substances and wherever hazardous substances *have come to be located* [emphasis added]." The document also advises that "the extent of contamination (site extent) may not be precisely determined at the time a site is listed on the NPL. In fact, the extent of the site may change significantly as the cleanup process progresses" (EPA 1996, pp.1). Recent scientific studies have discovered the presence of Aroclor 1268 outside of EPA-defined site boundaries, making the current delineation erroneous (Wirth et al. 2014; Balmer et al. 2011; Backer and Mellard 2014).



Source: EPA, LCP Chemicals Proposed Plan Public Meeting 2014

Secondly, sampling at the Brunswick LCP site is insufficient given the documented migration of contaminated media to Sapelo Island. Sediment and tissue sampling in the Turtle River must be conducted to determine the extent of contamination as well as the potential migration pathways to populations, such as residents of Sapelo Island, in order to accurately assess impacts of the contamination. As displayed in the figure, previous sampling efforts for Aroclor 1268 and other contaminants have focused little on Turtle River as a potential migration pathway.

Additionally, Turtle River and Sapelo Island must be added as operable units. Backer and Mellard (2014) noted that there is evidence to suggest that Aroclor 1268 appears to be widespread around the Brunswick area and that residents of Sapelo Island have been exposed to the specific PCBs found at the LCP site; residents' median levels for highly chlorinated congeners of PCBs are equal to or greater than the 95th percentile NHANES study for Non-Hispanic Blacks. Another recent study documented similar PCB congener profiles for sediments and fish between the locations of Sapelo Island National Estuarine Research Reserve and Brunswick (Wirth et al. 2014). These congener profiles were also consistent with the Aroclor 1268 signature noted in residents of Sapelo Island in the former study.

Lastly, there are boundary discrepancies among various documents pertaining to the LCP site. Tables 1 and 2 include differing acreage estimates for the area of contamination. Table 1 refers to Operable Unit 1 acreage estimates only, while Table 2 refers to site-wide estimates. Once site boundaries have been updated to include additional areas of contamination, one consistent estimate is warranted.

Table 1: OU1 acreage estimates

Source	Acreage Marsh (OU1)	Acreage Land (OU1)	Acreage Total [illegible] (OU1)	Link
EPA Brunswick LCP OU1 PP	670+			http://www.epa.gov/region04/foiapgs/readingroom/lcp_chemicals_site/superfund-proposed-plan-nov-2014.pdf
EPA Brunswick LCP OU1 Draft FS	≈662		98	http://www.epa.gov/region04/foiapgs/readingroom/lcp_chemicals_site/draft-feasibility-study-report-june-2-2014.pdf

Table 2: Site-wide acreage estimates

Source	Acreage Marsh (site-wide)	Acreage Land (site-wide)	Acreage Total Ground (site-wide)	Link
Honeywell Fact Sheet	681	120		http://www.lcpbrunswickcleanup.com/documents/fact%20sheet.pdf
EPA LCP Chemicals Georgia webpage	"550-acre site"			http://www.epa.gov/region4/superfund/sites/npl/georgia/lcpchemga.html#location

References

Backer, Lorraine C., Mellard, David. September 3, 2014. Polychlorinated Biphenyls (PCBs) in Georgia Coastal Environments and Populations. [Powerpoint slides].

Balmer, B. C., Schwacke, L. H., Wells, R. S., George, R. C.,Hoguet, J., Kucklick, J. R., Lane, S. M., Martinez, A.,McLellan, W. A., Rosel, P. E., Rowles, T. K., Sparks, K., Speakman, T., Zolman, E. S., & Pabst, D. A. 2011. "Relationship between persistent organic pollutants (POPs) and ranging patterns in common bottlenose dolphins (Tursiops truncatus) from coastal Georgia, USA." *Science of the Total Environment,* 409(11), 2094-2101.

EPS and Environ. 2012. "Remedial Investigation Report Operable Unit 1-Estuary, LCP Chemicals Site, Brunswick, Georgia: Final." Accessed 6 March 2015 http://www.epa.gov/region04/foiapgs/readingroom/lcp_chemicals_site/remedial_investi_report_october_2012.pdf

Honeywell. 2015. "Fact Sheet for the LCP Chemical Site."

U.S. Department of Health and Human Services, Public Health Service, Agency for Toxic Substances and Disease Registry, Division of Community Health Investigations. 2014. "Public Health Assessment, LCP Chemicals Superfund site and Adjacent Areas." Brunswick, Georgia, EPA Facility ID: GAD099303182.

U.S. Environmental Protection Agency, Region 4. 2013. "Glossary of Superfund Technical Terms." Accessed 20 February 2015. http://www.epa.gov/region4/superfund/qfinder/glossary.html#npl

U.S. Environmental Protection Agency. 1996. "Clarifying the Definition of 'Site' Under the National Priorities List." Accessed 2 March 2015 http://www.epa.gov/superfund/sites/npl/hrsres/policy/sitedef.pdf.

U.S. Environmental Protection Agency. 1995. "Superfund Program Representative Sampling Guidance, Volume 5: Water and Sediment, Part II--Groundwater." Accessed 6 March 2015 http://www.epa.gov/region9/qa/pdfs/fieldsamp-sfguidance-vol5.pdf

U.S. Environmental Protection Agency, Region 4. 2015. "LCP Chemicals Georgia: Site Location and Background." Accessed 6 March 2015 http://www.epa.gov/region4/superfund/sites/npl/georgia/lcpchemga.html#location

U.S. Environmental Protection Agency, Region 4. 2014a. "Superfund Proposed Plan: LCP Chemicals Superfund Site Operable Unit 1."

U.S. Environmental Protection Agency, Region 4. 2014b. "Feasibility Study: LCP Chemicals Superfund Site Operable Unit No. 1 (Estuary)."

Wirth, E., Pennington, F., Cooksey, P., Schwacke, L., Balthis, C., Hyland, J., & Fulton, M. 2014. Distribution and sources of PCBs (Aroclor 1268) in the Sapelo Island National Estuarine Research Reserve. *Environmental Monitoring and Assessment*, 186(12), 8717-8726.

Modern Construction Methods for Salt Marsh Remediation

In the Proposed Plan, EPA states that the type of construction required for removal or treatment of contaminated sediments in the LCP salt marsh would cause "widespread physical damage to habitat and species" (USEPA 2014a, pp. 25). The EPA goes on to state that construction would also impact hydrology, "possibly in ways which are not readily anticipated or predictable" (USEPA 2014a, pp. 25). This line of thought leads the EPA to conclude that 48 acres is the largest possible removal action that would be sufficiently protective of the environment. These statements about salt marsh construction are not accurate. Construction in salt marshes is widely practiced and not nearly as environmentally detrimental as stated in the Proposed Plan. There are modern, accepted methods for construction in salt marshes that pose minimal disturbance risks to the surrounding ecosystems.

It is only later in the document (Section 7.6 Implementability) that EPA, by its own admission, states: "There are technologies and techniques available to meet the challenges associated with working in soft sediments in tidally influenced marsh areas. These include employing low-ground-pressure earthmoving equipment, telescoping conveyor belts for cap placement, shallow draft barges for water-based sediment removal and sediment capping, and hydraulic equipment to place thin-cover material." It is obvious there are technologies to attain effective remediation without irreparable damage to the marsh. There are also new technologies that should be considered before moving into the remedial design.

Use of Alternative Technologies

The Proposed Plan relies on sediment removal, capping, and thin-cover placement for contaminant remediation at the site. Modern remediation methods exist that would work best to remediate a salt marsh without stressing the marsh beyond its ability to recover. EPA needs to consider using new remediation technologies that are more efficient and more environmentally sound than the ones recommended in the LCP Proposed Plan. Below we outline several alternative technologies that could be applied at the LCP site.

In Situ Technologies

PCB remediation is an expensive process and removal of the contaminated soil or sediment, whether by excavation or dredging, contributes a large part of that cost. These processes also risk disturbing and dispersing PCBs. In situ remediation technologies are designed to clean up PCBs without removal from the environment. Most in situ technologies remain difficult to implement on a large scale and are typically suited to low concentrations of contamination; however, several emerging technologies may be viable alternatives to traditional practices.

Bioremediation

Bioremediation is a process through which microbial degradation of PCBs is facilitated through creating a favorable environment for the process; this can be done through controlling the physical, chemical, and microbial aspects of the environment (EPA, 2012). This process generally begins with instigating anaerobic dechlorination, or the removing of chlorine atoms by anaerobic bacteria; this results in lightly chlorinated PCBs that are both less toxic and degrade more readily into inert molecules through the secondary process of aerobic biodegradation (Gomes, Dias-Ferreira, and Ribeiro 2013). Bioremediation may be of particular use in combination with active containment technologies such as reactive capping or phytoremediation.

There are many examples of bioremediation used in the remediation industry. One such example of note is the South Carolina company BioTech Restorations[1]. BioTech specializes in the bioremediation of chlorinated contaminants including PCBs through application of a proprietary protein "factor" which stimulates the indigenous microbial population and enhances its ability to degrade PCBs. While previously demonstrated in soils, dredged sediment could also be treated in this manner. Some of BioTech's successful remediation projects include the cleanup of the former New England Log Homes factory site in Great Barrington, Massachusetts and the Hercules Chemical Plant in Brunswick, Georgia.

Phytoremediation

Phytoremediation is an increasingly popular technology that employs specific plants to sequester, extract, and degrade contaminants in situ. Phytoremediation of PCBs works through three main pathways: i) uptake by the roots (sequestration), ii) degradation through plant enzymes, and iii) improving natural bioremediation through root activity in the soils (Gomes et al., 2013). While PCBs are partially retained in plant biomass, phytoremediation provides a noninvasive means of removing/degrading the contaminants. PCB contaminated plant matter may also be converted into biofuels during which the remaining concentrations would be destroyed. Phytoremediation can be implemented using a variety of plants; canarygrass and switchgrass were found to be particularly effective on soil (Chekol et al., 2004), while eelgrass was effective in aquatic sediment (Huesemann et al. 2009). Phytoremedation is also a good candidate for use in conjunction with bioremediation due to the root and rhizomatic boosts to biological activity.

There are several exampes of phytoremediation in the field. In 2015, the Iowa Superfund Research Program will finish a full scale study of employing phytoremediation to remove PCBs from soil and groundwater at a confined disposal facility in East Chicago. A similar test is being conducted on a PCB contamined wastewater pond in Altavista, Virginia. Several engineering and remediation firms use phytoremediationto remove PCBs including Edenspace, TRC Companies, and EADHA enterprises.

In Situ Sediment Ozonator

[1] Disclaimer: Environmental Stewardship Concepts, LLC worked with BioTech Restorations on the first draft of the QAPP for the Housatonic River cleanup. ESC completed the project in May 2014 and is no longer under contract to BioTech Restorations.

In situ Sediment Ozonation (ISO) is a new technology developed by the University of Utah in cooperation with the National Oceanic and Atmospheric Administration (NOAA). ISO uses a floating rig equipped with ozone reactors and conveyors to remediate without dredging. Ozone has been shown to react with PCBs by forming more biodegradeable products, as well as boosting biological activity in sediment or soil (Gomes, Dias-Ferreira, and Ribeiro 2013). ISO enhances this process using pressure-assisted ozonation which injects sediment with ozone and rapidly cycled pressure changes to increase the efficacy of the ozone (Hong 2008). The final report on the technology suggests that the materials to build ISO rigs are readily available in current dredging technology, and that contaminated sediment could be treated for as little as fifty dollars a cubic yard. This technology also naturally enhances biological activity and would be a logical choice to increase remediation efficiency of more passive technologies, such as bioremediation or phytoremediation.

Ex Situ Technologies

In many cases, the most practical means to treat a contaminated area is to remove the target media with dredging or excavation. The materials can then be transported and treated ex situ, or off-site. Treating contaminations ex situ allows for the use of more intensive treatment technologies that would be unsafe or impractical in situ. While incineration remains the most common ex situ technology, several emerging technologies are showing promise.

BioGenesis℠

BioGenesis Enterprises' proprietary BioGenesis℠ Soil/Sediment Washing Technology is one of the most well documented alternatives to incineration. BioGenesis℠ is a sequence of eight processing steps that treat contaminated sediment sufficiently to allow the post-treatment media to be used as high-end topsoil or construction grade products (BioGenesis 2009). BioGenesis℠ is designed to accommodate large volumes of contaminated sediment through the construction of a facility in a location where sediment can be directly delivered by barge or hydraulic pipe.

BioGenesis℠ has conducted several bench-scale studys and a recently completed full-scale demonstration of the technology in the New York/New Jersey Harbor which handled materials from the Raritan, Passaic, and Arthur Kill. According to the final report, the full-scale test facility was capable of remediating 250,000 cubic yards of sediment per year at a cost of $51-59 per cubic yard (2009). While initial costs of construction of these facilities is higher than other technologies, repeated demonstrations have provided enough data to conclude that BioGenesis℠ is an environmentally and economically sound alternative.

Mobile UV Decontamination

Researchers at the University of Calgary have developed a mobile PCB remediation unit that builds upon a study showing ultraviolet light's capability of effectively degrading PCBs in transformer oil, as well as soils and sediment (Kong, Achari, and Langford 2013). The project, backed by SAIT Polytechnic and IPAC Services Corp., is a 15 meter long mobile unit that combines UV and visible light technologies to degrade PCBs as much as 94%, at a fraction of the cost of inicineration while remaining on site (Unviersity of Calgary 2013). This technology is well suited for operation in areas where soil or sediment could be removed and processed nearby. The unit is currently designed to handle smaller contaminations but the project group plans to expand the technology to address the needs of larger remediation projects.

nZVI Dechlorination

Zero-valent iron nanoparticles (nZVI) is primarily an ex situ treatment based on zero-valent iron (ZVI), a technology which has been used to clean up aquifers contaminated with a variety of chemicals. Where PCBs are concerned, ZVI works through dechlorination into less toxic and more biodegradeable constituents (Gomes, Dias-Ferreira, and Ribeiro 2013). ZVI has been tested in the sediment of both the Housatonic River and New Bedford Harbor in Massachusetts; however mixed results have prevented ZVI from mainstream implementation. nZVI improves upon ZVI through a reformulation using nanoparticles which exhibits superior reactivity and more consistent removal of PCBs in groundwater and soil (Mikszewski 2004). While nZVI can be used in situ, due to limited research on the effects of nanoparticles on the environment, most commercial and academic uses are conducted off-site. However, NASA currently licenses an associated technology, emulsified zero-valent iron (eZVI), and has demonstrated successfully removing a variety of contaminants both in situ and ex situ (Parrish 2013).

<u>Removal Technologies</u>

When in situ treatment is not possible, removal of the contamination, whether it be industrial waste, soils, or sediment is required before ex situ remediation is possible. Where PCBs are concerned, the most common, and often most concentrated contaminations are found in river sediment in and around industrial areas. Heavy dredging equipment is often required to remove and transport the sediment, the use of which can be expensive economically and environmentally. However, advances in removal technologies can reduce these costs through more precise and focused application.

Environmental Dredging

Environmental dredges are designed with the understanding that dredging can re-suspend and disperse contaminants beyond the original site. Most environmental dredging uses hydraulic cutter dredges, which break up and then pump sediment and water through pipes to a desired location. The Bean technical Excavation Corporation's (Bean TEC) *Bonacavor* builds upon that standard using a hybrid model: mechanical excavation and hydraulic transport. This hybrid model allows more precise control of dredging which reduces unnecessary dredge area or depth and sediment disturbance. The *Bonacavor* also features an advanced onboard GPS and Crane Monitoring System (CMS) that provides precise control of the crane while dredging, as well as a Slurry Processing Unit (SLU) that increases solid concentration during dredging resulting in less water intake (Lally and Ikalainen). Smaller hydraulic cutter dredges have also been developed by companies such as Ellicott and Great Lakes Dredging (Randall, Drake, and li 2010). These dredges have smaller footprints and are able to facilitate removal at less cost and disturbance to the environment.

Activated Metal Treatment and Green PCB Removal

Technologies that allow PCBs to be removed without removing the contaminated media may offer alternatives to dredging in the future. NASA has also licensed two technologies that are designed to absorb PCBs from the environment for removal. The Activated Metal Treatment System (AMTS) is a solvent solution that can be applied to surfaces to remove PCBs from paints, caulk, or sealants (Parrish 2013). AMTS has been extremely successful during in situ remediation of industrial facilities where PCBs were used widely as paints and sealants on storage tanks, buildings, and other structures. The product allows extraction of PCBs without removal of the structures, whereupon the contaminants can be treated safely ex situ. While AMTS is primarily used for structure remediation, Bio Blend ® Technologies, a company currently licensing AMTS, is testing the technology in a variety of applications including in situ extraction of PCBs from soils and sediment (Parrish 2013).

Specific to sediment and soil contamination, NASA is also developing GPRSS, or Green PCB Removal From Sediment Systems, which is a system that uses a redeployable polymer blanket with "resevoir spikes." The spikes are treated with AMTS, which removes PCBs from sediment (Parrish 2013). The blanket is inserted into the target area, wherein the AMTS breaks down and absorbs PCBs; the blanket system can then be removed and decontaminated before reuse. While still in preliminary testing, GPRSS appears to be a promising technology for removal of PCBs without dredging.

Containment Technologies

Monitored natural recovery (MNR), a process by which PCBs are monitored and left to degrade naturally in the environment, is a remediation method employed in areas where removal of a contaminant is impractical or impossible. As natural degradation of PCBs is a slow process, the contaminant is often contained or capped to keep it from dispersing in the wider environment (Gomes, Dias-Ferreira, and Ribeiro 2013). This method has highly variable success, in large part due to the slow rate of natural PCB biodegradation. Advances in containment technology are increasingly implementing in situ treatments, such as bioremediation, to increase the outcome of the treatment.

Reactive Capping

While traditional capping passively contains a pollutant, reactive capping is an emerging technology that caps the designated area with additives that can absorb and immobilize, increase degradation, or reduce the bioavailability of PCBs; additives used in this process include Activated carbon, biochar, and metals such as zero-valent iron coated palladium (Gomes, Dias-Ferreira, and Ribeiro 2013). CETCO®, a minerals technologies company, markets the *Reactive Core Mat (RCM)*, a cap which can be tailored to meet the specific needs of a remediation project by augmenting the additives included in the product.

Aquablok® and Aquagate® are two complimentary reactive containment technologies from Aquablok Ltd that can be used to form a "funnel and gate" system in sediment. Aquablock® acts as a low permeability barrier to contain wastes while Aquagate® allows specific treatment materials for bioremediation or phytoremediation to interact with contaminated sediment, thus improving the remediation outcome.

Conclusions

Advances in PCB remediation and removal technologies provide viable alternatives to sediment removal, capping, and thin-cover placement. General conclusions include:

- Many viable technologies exist for in situ and ex situ treatment.
- Dredging and removal technology has improved as well and can be more economically and envrionmentally sustainable.
- As circumstances differ dramatically from one project site to another, each option should be assessed independently when determing appropriate remediation technologies.

The EPA needs to institute an evaluation of possible alternative technologies. This could mean re-opening the Feasibility Study.

References

Ahmad, Mushtaque, Michelle a Simon, Alex Sherrin, Mary Ellen Tuccillo, Jeffrey L Ullman, Amy L Teel, and Richard J Watts. 2011. "Treatment of Polychlorinated Biphenyls in Two Surface Soils Using Catalyzed H_2 O_2 Propagations." *Chemosphere* 84 (7). Elsevier Ltd: 855–62. doi:10.1016/j.chemosphere.2011.06.021.

ATSDR. 2000. *TOXICOLOGICAL PROFILE FOR POLYCHLORINATED BIPHENYLS.* Atlanta, Georgia.

BioGenesis. 2009. *Demonstration Testing and Full-Scale Operation of the BioGenesis Sediment Decontamination Process.* Keasbey, New Jersey.

Chun, Chan Lan, Rayford B Payne, Kevin R Sowers, and Harold D May. 2013. "Electrical Stimulation of Microbial PCB Degradation in Sediment." *Water Research* 47 (1). Elsevier Ltd: 141–52. doi:10.1016/j.watres.2012.09.038.

Denyes, Mackenzie J, Valérie S Langlois, Allison Rutter, and Barbara a Zeeb. 2012. "The Use of Biochar to Reduce Soil PCB Bioavailability to Cucurbita Pepo and Eisenia Fetida." *The Science of the Total Environment* 437 (October). Elsevier B.V. 76–82. doi:10.1016/j.scitotenv.2012.07.081.

Gomes, Helena I., Celia Dias-Ferreira, and Alexandra B. Ribeiro. 2013. "Overview of in Situ and Ex Situ Remediation Technologies for PCB-Contaminated Soils and Sediments and Obstacles for Full-Scale Application." *Science of the Total Environment*. doi:10.1016/j.scitotenv.2012.11.098.

Hong, Andy. 2008. *In Situ Sediment Ozonator for Remediation of PCB , PAH , DDT and Other Recalcitrant Chemicals*. Salt Lake City, UT.

Huesemann, Michael H., Tom S. Hausmann, Tim J. Fortman, Ronald M. Thom, and Valerie Cullinan. 2009. "In Situ Phytoremediation of PAH- and PCB-Contaminated Marine Sediments with Eelgrass (Zostera Marina)." *Ecological Engineering* 35 (10): 1395–1404. doi:10.1016/j.ecoleng.2009.05.011.

Kong, Jiansong, Gopal Achari, and Cooper H Langford. 2013. "Dechlorination of Polychlorinated Biphenyls in Transformer Oil Using UV and Visible Light." *Journal of Environmental Science and Health. Part A, Toxic/hazardous Substances & Environmental Engineering* 48 (1): 92–98. doi:10.1080/10934529.2012.707856.

Lally, John, and Allen Ikalainen. "Field Testing Advanced Remedial Dredging and Sediment Transport Technologies at the New Bedford Harbor Superfund Site", no. 617: 1–4.

Lauby-Secretan, Béatrice, Dana Loomis, Yann Grosse, Fatiha El Ghissassi, Véronique Bouvard, Lamia Benbrahim-Tallaa, Neela Guha, Robert Baan, Heidi Mattock, and Kurt Straif. 2013. "Carcinogenicity of Polychlorinated Biphenyls and Polybrominated Biphenyls." *The Lancet. Oncology* 14 (4): 287–88. doi:10.1016/S1470-2045(13)70104-9.

Mikszewski, Alex. 2004. "Emerging Technologies for the In Situ Remediation of PCB-Contaminated Soils and Sediments : Bioremediation and Nanoscale Zero-Valent Iron Prepared by."

Parrish, Lewis M. 2013. *Environmental Remediation Technologies*. NASA.

Randall, R, A Drake, and W Cenac Ii. 2010. "IMPROVEMENTS FOR DREDGING AND DREDGED MATERIAL HANDLING", 104–22.

Sowers, Kevin R, and Harold D May. 2013. "In Situ Treatment of PCBs by Anaerobic Microbial Dechlorination in Aquatic Sediment: Are We There Yet?" *Current Opinion in Biotechnology* 24 (3). Elsevier Ltd: 482–88. doi:10.1016/j.copbio.2012.10.004.

Unviersity of Calgary. 2013. "New Technology from University Destroys Hazardous PCBs Using UV Light | UToday | University of Calgary." http://www.ucalgary.ca/utoday/issue/2013-09-11/new-technology-university-destroys-hazardous-pcbs-using-uv-light.

U.S. Environmental Protection Agency (a), Region 4. November 2014. Superfund Proposed Plan: LCP Chemicals Superfund Site Operable Unit 1.

U.S. Environmental Protection Agency (b), Region 4. June 2, 2014. Feasibility Study: LCP Chemicals Superfund Site Operable Unit No. 1 (Estuary).

U.S. Environmental Protection Agency. 2012. "Technology Alternatives for the Remediation of PCB Contaminated Soils and Sediments", 1–40.

Zhang, Wei Xian. 2003. "Nanoscale Iron Particles for Environmental Remediation: An Overview." *Journal of Nanoparticle Research*. doi:10.1023/A:1025520116015.

FROM: Norman Meade, National Oceanic and Atmospheric Administration

TO: Galo Jackson, USEPA RPM

CC: Jim Brown, Georgia Department of Natural Resources
Spud Woodward, Georgia Department of Natural Resources
Strant Colwell, US Fish & Wildlife Service
Tom Dillon, Dillon Environmental Consulting

SUBJECT: LCP Natural Resource Trustees Comments on the OU1 (Marsh) Proposed Plan for the LCP Superfund Site, Brunswick, GA

DATE: January 29, 2015

On behalf of the LCP Natural Resource Trustees ("Trustees"), we would like to take this opportunity to provide comments on the subject Proposed Plan (PP) from a natural resource damage assessment (NRDA) perspective. Please contact me with any questions or concerns.

1. The subject PP concludes that Alternative 6 is the preferred alternative for remedial action in the LCP Marsh. The three major components of this alternative are: 1) dredging 7 acres of the LCP Ditch and Eastern Creek, 2) installation of armored caps in 6 acres of tidal creeks, 3) application of a thin layer sand cap (6-9 inches) over 11 acres of marsh largely along either side of the Eastern Creek. For reasons given below, the Trustees believe this remedial action may not restore the injured natural resources as quickly as the other alternatives that were considered. Moreover, Alternative 6 may not represent a permanent solution to environmental contamination at the LCP Marsh and the larger Turtle-Brunswick River Estuary.

a. The LCP Ditch and Eastern Creek were dredged in 1998-1999 along with approximately 13 acres of saltmarsh in Domain 1. Now, 15 years later, the LCP Ditch and Eastern Creek must be dredged again. Without a more comprehensive remedial action (i.e., Alternative 2 in the PP), the Trustees are concerned that re-dredging these tidal creeks now may not restore the marsh to its baseline condition.

b. The PP describes armoring material for the capped tidal creek areas as "coarse sand and/or gravel". This appears to be inconsistent with the descriptions in Appendix H of the 2013 Feasibility Study which specify an "armor stone layer for erosion protection" (§3.3.1) or an "armor stone cap" (Table H-4). Furthermore, the placement of an armored stone layer (or any hard substrate) on top of 6 acres of capped tidal creek areas, will likely result in the development of oyster reef communities similar to those currently found on large pieces of concrete that line the LCP Ditch. While oyster reef communities can provide important ecological services, in this particular case, a 6-acre attractive nuisance will likely be created if Alternative 6 is implemented. This is because oysters efficiently bioaccumulate site contaminants such as mercury, lead and Aroclor 1268 thus making these contaminants available to higher trophic level organisms; e.g., blue crabs, black drum. As a result, capping 6 acres of tidal creeks under Alternative 6 may actually ***enhance*** entry of site contaminants into the marsh food web. This possibility must be studied as part of the post-remedial monitoring plan.

c. The arguments presented in support of installing a thin layer (6-9 inches) sand cap over 11 acres of LCP salt marsh as a method of reducing the risk to the benthic community are unconvincing. At the very least, placing sand over silty vegetated marsh surface may alter the benthic community and hydrology in ways not foreseen by the modeling that was performed.

d. The PP (page 29) provides a justification for the thin layer cap saying, "Thin-cover placement is best suited for wetlands or marsh environments where tidal energy and potential erosion is at a minimum.". This minimal tidal energy requirement seems inconsistent with the LCP marsh's 7-10 foot semi-diurnal tidal range and periodic high energy storm events. EPA's National Remedy Review Board expressed a similar view in their March 28, 2014 Memo saying, "The Board is concerned about the long-term permanence aspects of the proposed thin cover placement" (page 5, March 28, 2014 Memo). "Long-term effectiveness and permanence" is the first Primary Balancing Criteria that EPA is required to use when evaluating remedial alternatives. Dredging certainly meets this criterion especially when compared to the more questionable thin layer (≈6-9 inches) capping in a system experiencing large daily tidal fluctuations and periodic high energy storm events. EPA's National Remedy Review Board echoed this same concerns when they recommended to EPA Region 4 that they "consider a contingent remedy approach due to the uncertainty regarding the long-term permanence aspect of the proposed thin cover and capping components of alternative 6" (page 5, March 28, 2014 Memo). The permanence and effectiveness of the thin layer capping will need to be studied as part of the post-remedial monitoring.

e. It is not exactly clear in the PP how Preliminary Remedial Goals (PRGs) and Cleanup Levels (CULs) were derived and whether they are protective of human health and the environment. For example, the ranges of PRGs for the protection of the Benthic Community (page 22 of the PP) are greater than the ecologically protective Remedial Goal Objectives (RGOs) initially developed in the Baseline Ecological Risk Assessment (BERA) (see page 92 of the BERA and the values below). The recommended CULs in the PP are higher still (page 42 of the PP and below). These CULs represent the highest value in the range of PRGs in the PP. The PP does not clearly explain how these PRGs and CULs can drift ever higher, yet still be protective of the benthic community. Further, the PP does not explain whether a similar progressive relaxation of PRGs and CULs was allowed for fish and wildlife receptors.

COC	BERA RGOs →	PP PRGs →	PP CULs
Mercury	1.4-3.2 ppm	4-11 ppm	11 ppm
Aroclor 1268	3.2-12.8 ppm	6-16 ppm	16 ppm
tPAH	0.8-1.5 ppm	4 ppm	4 ppm
Lead	41-60 ppm	90-177 ppm	177 ppm

2. As noted above, approximately 13 acres of saltmarsh were excavated and backfilled with clean material in 1998-1999. Visual observations afterwards suggested very rapid recovery of the saltmarsh vegetation (see 2-year post-removal photo in Figure 2-10 of the 2013 OU1 Feasibility Study). Despite this site-specific experience of rapid recovery, the subject PP opts for other less permanent methods of remediation. The PP also repeatedly states that additional dredging and excavation would create unnecessary "destruction", "unwarranted harm" and "significant damage", which is not supported by the evidence. EPA's National Remedy Review Board reached a similar conclusion stating, "The PRPs do not provide any site-specific information to indicate that marsh restoration at this site is particularly difficult and, in fact, earlier removal actions have excavated and restored wetlands at the site already." (pages 6-7, March 28, 2014 Memo). In their Memo, the Remedy Review Board recommended dredging the 6 acres of tidal creek currently slated for capping under Alternative 6.

3. The above comments are offered from the perspective of the LCP NRDA Trustees, which differs slightly from that of EPA. At Superfund sites, the Trustees are charged with: 1) restoring ecological services back to baseline (if possible) and 2) compensating the public for interim losses through restoration projects. As a general rule, more thorough cleanups at a Superfund site translate into smaller interim losses and a more rapid return to baseline. Consequently, the LCP NRDA Trustees would rather see implementation of a more aggressive remedial action. However, the NRDA Trustees also recognize that important uncertainties are always present in ecological risk assessments and evaluations of remedial alternatives. Therefore, if Alternative 6 is implemented, the Trustees strongly urge that a comprehensive, science-based monitoring plan be designed and implemented. The plan should be capable of quantifying the rate of recovery (return to baseline) soon after the remedial action. Additionally, the plan should incorporate specific numerical "triggers" for further clean up action as described in §8.0 of the PP. The importance of post-remedial monitoring was also cited in EPA's National Remedy Review Board's March 28, 2014 memo. The Trustees concur with the Board's recommendation to develop a fish tissue monitoring plan using extant EPA guidance; i.e., Sediment Assessment and Monitoring Sheet (SAMS) #1 " Using Fish Tissue Data to Monitor Remedy Effectiveness" (2008) which can be found at http://www.epa.gov/superfund/health/conmedia/sediment/documents.htm.

GEC
Glynn Environmental Coalition

P.O. Box 2443, Brunswick, GA 31521

March 16, 2015

Mr. Galo Jackson, Ms. Shelby Johnston
Remedial Project Manager
South Superfund Remedial Branch
U.S EPA Region 4
61 Forsyth Street, SW
Atlanta, GA 30303-8960

Mr. Jackson and Ms. Johnston,

The purpose of this letter is to request information, and submit questions and comments to be included in the official record for the LCP Chemicals Superfund Site Marsh Proposed Plan, Operable Unit One (1).

The Feasibility Study is built off the information contained in the Baseline Ecological Risk Assessment (BERA), Human Health Baseline Risk Assessment (HHBRA), and the Remedial Investigation (RI). The following comments will strive to address the LCP Marsh Feasibility Study (FS) by covering comments, questions, and concerns about these documents, and finally the Feasibility Study and the Proposed Plan (PP).

The period of time, 20 years, over which the LCP Site data were collected presents challenges of its own just related to the long period over which the data and studies were produced. These include: 1. Changes in Potentially Responsibility Party's Consultants and staff; 2. Continuity of EPA On-Scene Coordinators and Remedial Project Managers; 3. Demographic and socio-economic changes within the surrounding community; 4. Advances in scientific knowledge; and, 5. New and relevant research, studies, and reports concerning the marsh, estuary, and sound system in which the LCP Chemicals Site is located. Similarly, the institutional knowledge within the stakeholder agencies has undergone changes as key people retired, new hires came on and attempted to read the documents and get a grasp of the site conditions. Meanwhile, the sampling and analysis efforts declined and the existing data became dated and increasingly of limited value. Within this landscape of challenges, new agency personnel, and a feeling of urgency to get a Feasibility Study completed, the Proposed Plan for the LCP Marsh Operable Unit One (1) was produced.

The LCP Site documents reflect the challenges identified above. The following comments, questions, and studies and reports are presented to increasing the robustness and accuracy of the Feasibility Study and Proposed Plan, fully knowing the challenges the authors were encountering.

In the final analysis, the prudent course of action might be to use this point in time to develop a sampling and analysis plan, and a firm timeline for completion. There is an urgent need to obtain the information needed to produce complete BERA, HHBRA, and RI data needed to produce a viable FS and Proposed Plan with a measurable monitoring criteria to track and measure obtainment of remedial goals on a set timeline. The Proposed Plan should also establish follow-up actions to be taken if the remedial goals are not met at set points in time. Since the Potentially Responsible Parties (PRPs) have failed to produce the data needed to complete a viable remedial plan over an extended period of time measured in decades, the EPA is strongly urged to obtain the services of a competent contractor, such as Black & Veatch, to complete data collection needed and proceed with the Remedial Action without further delay. If need be, the EPA should use the available data to articulate the need for an "EPA Emergency Response and Removal Action" and designate the LCP Site a "Time Critical Action". The data identified in the following comments will support and articulate the need for a time critical action by the EPA.

With a full understanding of the challenges encountered during the 20 years leading up to the release of the proposed plan, the following comments are respectfully submitted. We trust the comments will help formulate a plan to develop a Proposed Plan that will obtain a timely cleanup and end the risk to human health and the ecosystem upon which the economic future of Brunswick and Glynn County, Georgia, depend.

Sincerely,

Daniel Parshley, Project Manager

Enclosures

INDEX

Baseline Ecological Risk Assessment (BERA) Comments and Questions

Cordgrass *(Spartina Alterniflora)*

The Baseline Ecological Risk Assessment (BERA) recognized Spartina as key to the functioning of the estuarine system, and the burden of Chemicals of Potential Concern (COPCs) were higher than biota at reference stations. Literature identifies Spartina as the base of the nutrient sharing system, and as such a key component to all life cycles in the estuarine system. Also noted was the Site is primarily vegetated with Spartina, which is also known as cord grass and marsh grass.

The BERA fails to identify why the marsh ecosystem is important, and in particular the nutrient transport system with *Spartina alterniflora* as the key species.

Why does the BERA fail to describe the marsh ecosystem in a manner that shows an understanding and knowledge about the movement of nutrients and Chemicals of Concern (COCs) within the ecosystem?

Why, in the entire 1002 page BERA, is *Spartina alterniflora* detritus potential to transport COCs not mention even once?

Has Spartina been identified and an initial vector for mobilization of sediment bound chlorinated hydrocarbons, such as PCBs, into the estuarine food chain (Mrozek, 1982)?

Have studies shown Spartina to be a key factor in bioaccumulation of PCB in detritus and an important means of entry for this pollutant into estuarine food webs (Marinucci, 1982)?

Did the LCP Marsh Remedial Investigation reported:

> "Sorption to organic carbon is the primary mechanism controlling the mobility and bioavailability of PCBs and PAHs in sediment, and also one of several mechanisms affecting bioavailability of divalent metals, including lead and mercury. Organic carbon is abundant in marsh habitat (e.g., detritus within the Spartina mud flats and dissolved organic carbon (DOC) from plant exudates, specifically fulvic and humic acids within the root zone of sediments). Sorption to soot, pitch, coke, and other black carbon forms can greatly decrease bioavailability of many hydrophobic organic compounds compared to amorphous organic carbon (Cornelissen et al., 2005)."

Does the statement from the LCP Marsh Remedial Investigation indicate the authors understood the importance of Spartina to the bioaccumulation and transport throughout the echo system and movement through the food web?

If so, why were steps to sample all parts of the Spartina plant not taken during the remedial investigation?

Has scientific literature noted a differentiation between the root rhizome stem and leaves and their ability to bioaccumulate PCBs?

Did *Sustainable Development in the Southeastern Coastal Zone* note .33 ppm in Spartina shoots, 2.80 ppm in roots (Army Corps of Engineers)?

__Cordgrass *(Spartina)* and Mercury__

The BERA noted:

> "Cordgrass (Spartina alterniflora) was characterized by concentrations of total mercury that ranged from a mean of 0.02 mg/kg (dw) in the Purvis Creek area to a mean of 0.147 mg/kg (dw) in the Main Canal area vs. 0.005 mg/kg in the Troup Creek reference location (Table 4-6a). Methylmercury frequently could not be detected in cordgrass and, when detected, averaged just 9.93 percent of concentration of total mercury (Appendix F)."

Why did the BERA limit resting for mercury to a section of the leaf 15 cm above the sediment?

Does Spartina testing most frequently and routinely sample the root, rhizome, stem, leaf, and detritus due to the selective bioaccumulation noted with Spartina (Mrozek, 1982; Windham, 2001)?

What was the decision-making process used to limit sampling to just a small section of the leaf, which is know from literature to be the part of the plant with the least bioaccumulation potential?

Were the BERA authors aware that in the fall, the root-rhizome material makes up 78% of the total live biomass and by spring this decreases to 53% (Schubauer and Hopkinson 1984)?

Did the authors of the BERA consider the Manatee has been seen grazes on the Spartina in the LCP Site area?

What was the decision-making structure used to limit the Spartina sampling to the leaf 15 cm above the sediment?

Were stakeholder agencies consulted such as the National Oceanographic and Atmospheric Association (NOAA) or U.S. Fish and Wildlife consulted before this Spartina sampling plan was limited to just the leaf 15 cm above the sediment?

What peer reviewed journal articles were used to support the decision to limit Spartina sampling to 15 cm above the sediment?

Did the BERA consider the potential for Spartina to bioaccumulate metals like mercury from sediment and excrete them from the leaf (Weis, 2003; Windham, 2001)?

What would the implications of Spartina growing on top of mercury contaminated sediments?

Would removing the Spartina from mercury contaminated sediments result in less transport from sediments into the ecosystem?

Did the BERA examine mercury transport via Spartina (Weise, 2003; Windham, 2001)?

Notable is the BERA fails to mention the same glands that excrete salt do excrete mercury. What was the reasoning of the BERA to exclude this critical fact about the excretion and bioaccumulation properties of Spartina?

Did the authors of the BERA do their due diligence and research to identify the potential of the biota to bioaccumulate and transport identified COCs? If not, why not?

Did any stakeholder agencies comment about the apparent selective use of data or data appeared to be censored?

Could the oversight of including mercury excretion along with salt from Spartina leaves be interpreted by a reasonable individual as the selective use of data or the censorship of data?

What is the EPA's explanation for such a critical piece of information, such as mercury excretion, being excluded from the BERA?

How would the exclusion of mercury excretion impact the risk calculations used to develop the Feasibility Study?

Would mercury levels in Spartina leaves be a critical piece of information for evaluating the potential impact to marine mammals like Manatees that use this plant as a primary food source?

Being that the St. Simons Sound and Turtle River are documented Manatee calving grounds, what significance is mercury in the Manatee's primary food source while lactating?

<u>Cordgrass *(Spartina)* and Aroclor 1268</u>

The BERA noted:

> Aroclor 1268 concentrations in cordgrass from the Site ranged from a mean of 0.096 to 0.261 mg/kg, in comparison to 0.0134 mg/kg at the reference location. The maximum concentration of 0.614 mg/kg occurred in Domain 1 at the AB Seep Location.

The BERA appears focused on Aroclor 1268. Were the following Aroclors found at the LCP Site – Aroclor 1016, Aroclor 1221, Aroclor 1248. Aroclor 1254, and Aroclor 1260

(ATSDR, 2014a)?

What PCB congeners are present in Aroclor 1016, Aroclor 1221, Aroclor 1248. Aroclor 1254, Aroclor 1260, and Aroclor 1268?

Do the PCB congeners found in Aroclor 1016, Aroclor 1221, Aroclor 1248, Aroclor 1254, Aroclor 1260, and Aroclor 1268 include those with dioxin and furan properties?

Were the non-dioxin-like and dioxin-like effects of the specific PCB congeners analyzed in the BERA, or was only a general Aroclor 1268 analysis conducted?

Were the EPA BERA protocols for analysis of PCB dioxin and non-dioxin-like effects conducted as part of the 2003 BERA for the LCP Site marsh (EPA, 2003)?

Were all congeners of PCBs detected at the LCP Site measured in the Spartina samples collected 15 cm above the sediment?

Was the PCB congener analysis limited to those found in Aroclor 1268?

What is the significance of the BERA focusing on Aroclor 1268?

Was the BERA limited to an analysis of Aroclor 1268? If not, where can the chemicals with similar modes of physiological action, like the other Aroclors, dioxin, and furans be found?

Was a Toxicological Equivalency Factor (TEF) developed for all the PCB Aroclors, dioxins, and furans found in Spartina? If not, why not?

> "The BERA limited Chemical of Concern (COCs) in Spartina (sp.) were limited to three - Mercury, Aroclor 1268, and lead."

What was the reasoning used to limit the COCs examined in Spartina?

Were toxicological effect found in organisms at levels lower than expected when the toxicological factors were limited to just the three factors: mercury, Aroclor 1268, and lead?

BERA Appendix E states:

> Smooth cordgrass occurs in all of the above-identified marsh zones, in great part because of its special adaptations that allow it to live where few other plants could survive. These adaptations include a tough and well-anchored root system, as well as narrow, tough blades and special glands that secrete excess salt, permitting it to withstand high heat and daily exposure to salt water.

The Spartina alterniflora nutrient recycling system, critical to the estuarine marsh system,

is notably missing from the BERA.

Why is the crucial nutrient recycling system the Spartina alterniflora serves for the estuary noticeably missing from the BERA?

The BERA is devoid of any discussion about the PCB bioaccumulation properties of Spartina in marsh environments. The potential for Spartina to be a significant reservoir of PCBs in the environment has not been identified or quantified, which would be a major factor in FS to identify areas for removal and determining total PCB mass calculation. As a major, if not the most primary and basic mechanism for transporting PCB in to biota at the base of the food chain, the lack of any information in the BERA is a glaring shortcoming in the report. Failure to be cognoscente of the potential for Spartina to bioaccumulate PCBs and incorporate them into the base of the food chair raises doubts about the technical expertise of the authors of the BERA work plan, or points to development of a work plan design to produce predictable results with the intent to under reporting actual levels of COCs. Regardless of the reason or intent, the fact remains that a major flaw in the BERA needs to be rectified.

Fiddler Crabs (*Uca minax* or red-jointed, *Uca pugnax* or mud fiddler, *Uca pugilator* or sand fiddler)

> "The greatest mean number of crabs, 196 individuals / m2 of substrate, was reported in a habitat characterized by medium-sized *Spartina* (0.5 -1.49 m in height), while 176 and 94 individuals / m2 were observed, respectively, in short *Spartina* (<0.5 m tall) and on essentially barren substrate (absence of vegetation)."

Why does the BERA limit reporting of PCBs in fiddler crabs to Aroclor 1268 (BERA, pg. S-5)?

Why does the BERA report found that they were fiddler crabs present in numbers (200 young and adult crabs per square meter) that might be expected to occur in a relative pristine marsh, but not quantify the amount of sediment brought to the surface on an annual basis?

Is the amount of sediment excavated from the sediments by Fiddler Crabs important information for remedies using capping of marsh sediments?

Why were Fiddler Crabs sampled at a location previously remediated (BERA, Pg. 55)?

Was the BERA data concerning fiddler crab abundance biased by sampling in a previously remediated area?

Can the encountering of the membrane at 40 cm be used to infer the minimum depth of the fiddler crab burrows are 15.75 inches (BERA, pg. 55)?

Does the BERA state "these burrows, which often extend to 2 ft in depth .... (BERA, pg. E-2)? What are the implications of sediment excavation activity by fiddler crabs to remedies involving placement of capping material over the marsh?

What is the quantity of sediment brought to the surface annually by over 200 fiddler crabs per square meter?

What is the quantity of sediment brought to the surface annually by the remaining biota (other than Fiddler Crabs)?

Mink *(Mustela vison)*

Even though mink are indigenous and wide-spread in coastal Georgia, mink are noticeably missing from the Site marsh indicating reproductive failure. Furthermore, no mink analysis is presented in the BERA. The reasonable assumption is the Chemicals of Concern (COCs) levels are sufficiently high around the Site to prevent reproductive viability in mink. **The range of mink should be established as a baseline before the Estuary Remedial Action (RA) is implemented.** The RA should sufficiently reduce COCs to allow, at a minimum, a viable reproducing mink population in the Site area.

Does the EPA intend to make identification of the mink range within the turtle River's system and the St. Simons sound estuary a priority?

If the EPA is can make mink range a priority what is the timeline for collection of this data?

The BERA notes the presence of mink in the estuary and notes these are animals found in the estuary. But, in the case of the LCP Site, and the BERA, the absence of any mink in the area is glaringly noticeable. Mink are sensitive to the chemicals present at the LCP Site, such as PCBs. It is unknown why the authors of the BERA or the EPA did not understand the significance of the absence of mink or make note of this fact, even though the absence was noted by the EPA previously (USEPA, 1997).

After identifying the Mink as an indigenous species missing from the ecosystem surrounding the LCP Chemicals Superfund site, why did the EPA eliminate the species from the baseline ecological risk assessment when it was obviously one of the most impacted species?

Is the EPA aware that mink are a species susceptible to adverse impacts from PCB exposure and a good indicator species for measuring ecological impacts?

What is the EPA's rationale for elimination of the mink from the BERA?

What is the EPAs explanation for the absence of mink from the LCP Site?

Does the EPA intend to identify the "dead zone' around the LCP Site where mink are absent?

Does the EPA intend to define the area where mink are absent, and delineate where viable and sustainable mink populations can be found?

If the EPA does determine the extent of the area where the contamination has eliminated the mink population, and will mink be used as a monitoring criteria to assess the Remedial Action?

If the EPA does intend to use the mink and a monitoring indicator, will this be placed in the Record of Decision and Consent Decree for the LCP Site?

Will the EPA recommend mink be used as monitoring criteria for assessment of the remedial action? If not, why not?

The BERA note (Section 6.2.2.5):

> An important source of uncertainty associated with this assessment endpoint is how well the river otter exposure model that represents a top-level piscivorous mammal could be extrapolated to dolphins and whether the TRV (based on Aroclor 1254 effects to mink) could reasonably be applied to dolphins.

Why should the EPA use otters when mink are an indigenous species and the indicated as the proper species to use?

Does the EPA agree that if an exposure model can be applied from the mink to the dolphin, the model can be applied from the dolphin to the mink?

The lack of a viable reproducing mink population does not indicate no problem, but rather quite the opposite. Alarms should be going off when an indigenous species shown to be sensitive to the chemicals released from the LCP Site is missing. The only conclusion can be a dead zone is surrounding the site. The baseline monitoring plan should use the mink as an indicator of marsh and estuary recovery. The area without a viable mink population should be delineated and help define the area of reproductive failure. The argument that a key species in the estuary is "just not present in this area" should not be accepted. The correct observation is "this is the only area where the mink is not present". The mink was suggested as an indicator of dolphin health by the Potentially Responsible Parties via dosing with Aroclor 1268. Notable is the lack of any mink sampling within the Turtle River estuary, which would have produced a real life's samples to use as an indicator of dolphin health. But these mink samples are not needed as an indicator of dolphin health because there is a wealth of data that has been collected from the resident dolphin population in coastal Georgia. It is now known dolphins are sick and lack of any reporting concerning this situation greatly questions to credibility or viability of the BERA as a decision-making document.

Is the EPA aware that PCBs have been associated with low mink kit survival and mink are a sensitive population to the toxic effects of PCBs (Bursian 2006; Bursian, 2013)?

Will the EPA consult literature and establish a remedial action level that will result in the recovery of the mink population at the LCP Site?

<u>Dolphins</u>

As previously noted, the lack of any information concerning the resident dolphin population in Turtle River and coastal Georgia is a glaring omission from the BERA. This omission is so glaring as to question the motives of the authors of the BERA. Since at least 2004, is been known that though dolphin population is grossly contaminated and this fact is been well documented. Furthermore stakeholder agencies have collected samples from the resident dolphin population, analyze the samples, and even conducted health assessments on the dolphin population. But the authors of the BERA have chosen to ignore this wealth of data.

What is the EPA's explanation for not including the dolphin data in the BERA?

Did the EPA failed to communicate with the stakeholder agencies, including the Georgia Department of Natural Resources, the National Oceanic and Atmospheric Administration, and the US Fish and Wildlife Service concerning the dolphin sampling and analysis?

Was the EPA oblivious to the fact that the same people that were producing data on the LCP Chemicals Superfund site were also doing sampling and analysis on the resident dolphin population for PCBs associated with the LCP site?

Notable are people who were sampling the dolphins and producing peer reviewed journal articles had also worked with EPA On-Scene Coordinators at the LCP Chemicals Superfund Site. It stretches the imagination to think that the EPA was not aware of the gross contamination in the resident dolphin population.

Inshore resident dolphin (T. truncates) populations exhibit long-term fidelity to specific estuaries and making them excellent sentinels for assessing the impact of stressors on coastal ecosystem health (Pulster, 2008). It is not surprising that the implications to human health were obvious to those studying the dolphins and they questioned the impact to the people who regularly and habitually consumed fish from the same waters (Schwacke, 2012).

The plight of the dolphins in Turtle River has been known since at least 2004. It was noted in the PCB levels were 10 times higher than those noted in the Savannah area dolphins (Pulstera, 2008). Literature reports 102 bottlenose dolphin blubber samples being analyzed from animals in Georgia (Balmer, 2011). The researchers noted that the levels of PCBs in the dolphins was associated with a point source near Brunswick Georgia or the LCP Chemicals Superfund site. The study was robust and photo identification was used to identify individual dolphins. Also noted were that the male dolphins in Turtle River had the highest concentrations of PCBs reported for any marine mammal, worldwide. The Aroclor 1268 levels were noted to be highest in the Brunswick Georgia area and decreasing with distance (Balmer, 2011).

The dolphins in the Turtle River estuary system were given a physical examination in addition to being sample for levels of PCBs. The result of the examination was the identification of anemia, hypothyroidism, and immune suppression associated with PCB exposure (Schwacke, 2012).

A high proportion of the sample dolphins suffer from anemia (26%), which is a finding previously reported being observed with Aroclor 1254. Furthermore the dolphins showed reduced thyroid hormone levels which were negatively correlated with PCB concentrations measured in the blubber. There was a correlation between immunity decrease and blubber PCB concentrations, which is suspected to increase susceptibility to infection and disease. Contrary to the assertions of the Potentially Responsible Parties that Aroclor 1268 is less toxic than other forms of PCBs, the re-searchers found the PCB mixture dolphins were exposed have substantial toxic potential and potential impacts on other top-level predators. Humans were identified as one of those other top-level predators consuming the same as fish species from the same estuary (Schwacke, 2012). **The significance of this empirical evidence and implications to human health appears to have been ignored by the EPA. At a minimum, the EPA has not conducted due diligence by conducting a basic literature search for the Superfund Site name for data and studies pertinent to the Site and the EPA decision-making process.**

The other notable impacts to the dolphins in Georgia coastal waters were skin disease, and specifically lesions. Again, the Brunswick Georgia site was found to have the highest incidence of skin lesions in bottlenose dolphins when compared to Sapelo Island Georgia and Sarasota Bay Florida (Hart, 2012).

The dolphins in the Turtle River estuary having the highest PCB concentrations required for any Marine mammal has raised considerable concern for both the dolphins and humans consuming seafood from this region of the Georgia coast. Dolphin densities were compared for the Brunswick Georgia area and the Sapelo Island area. The researchers noted that dolphin density in total abundance were sadistically higher in the Sapelo Island area than in Brunswick. Furthermore, anthropogenic stressors were identified as an important factor and potentially the cause of the differences in abundance density and habitat use observed (Balmer, 2013).

Research was done to establish the level of PCBs in fish that would result in tissue levels below the health effects threshold in dolphins. The model developed estimated that a dietary PCB concentration that did not exceed 5.1 ng/g (parts per billion or ppb) would be required to be protective of 95% of the dolphin population (Hickie, 2013). Very notable is how close the proposed maximum dietary PCB concentration is to the level that is protective of human health and the high quantity seafood consumer.

Will the EPA include the large volume of data on the coastal Georgia resident and transient dolphin population into the BERA? If not, why not?

Does the EPA understand the implications to human health from the dolphin data?

Does the EPA understand that dolphins and humans eat the same fish species?

Will the EPA incorporate the dolphin data into the HHBRA? If not, why not?

Does the EPA intend to incorporate the large volume of dolphin data into their decision-making process for the propose plan for the marsh at the LCP Chemicals Superfund site?

Will the EPA established a maximum allowable level of 5.1 parts per billion (PPB) in fish as the goal for the LCP marsh cleanup?

Notable is dolphin studies were not included in the BERA but were utilized in the Human Health Baseline Risk Assessment (HHBRA) to argue the Aroclor 1268 at the LCP Site is distinct and recognizable (Pulster, 2005; Pulster 2008).

As noted in the HHBRA:

> "Polychlorinated Biphenyl (PCB) homologue analysis of sediment and biota were presented in Kannan et al. (1997) and Kannan et al. (1998). The homologue proportions are substantially similar to the proportions in Aroclor 1268. More recent work indicates the same conclusions (Sajwan et al., 2008; Cumbee et al., 2008; Pulster and Maruya, 2008; Pulster et al., 2005)."

What is the rational for inclusion of the dolphin studies in the HHBRA to argue for only Aroclor 1268 sampling and not including them in the BERA?

Will the EPA utilize all the dolphins studies identified in these comments and the corresponding references to formulate Remedial Action levels protective of the resident dolphin population?

The HHBRA discusses using the dolphin data in the rationalizing for limiting sampling to Aroclor 1268 (Pulster, 2005; Pulster, 2008).

Were Aroclor 1254 found in 81 samples (9%), and Aroclor 1260 found in 37 (4.1%) in upland samples (ATSDR, 2014a)?

If Aroclor 1254 and Aroclor 1260 were found in upland samples, what was the EPA's rational for eliminating these PCB Aroclors from the COC to be sampled for in the LCP marsh?

Were other PCB Aroclors found in upland samples at the LCP Site, and if so, what was the EPA's rational for eliminating these from the COC to be sampled for in the LCP marsh?

Was PCB congener 206 established as the one defining Aroclor 1268 contamination from the LCP Site in coastal Georgia (ATSDR, 2014b)?

Is PCB congener 206 the most prevalent, or dominant, in Aroclor 1268?

Has a gradient of PCB congener 206 been found emanating from the LCP through sediment samples taken in coastal Georgia (ATSDR, 2014b)?

Using PCB congener 206 as an indicator of the boundaries of the LCP Site contamination, what are the geographical boundaries of the contamination from the LCP Site (ATSDR, 2014b)?

Did ATSDR compare and contrast total PCBs in fish between the Brunswick Georgia and Sapelo Island area (ATSDR, 2014b)? If so, what were the findings (differences quantified)?

Was the purpose of the ATSDR study to "Compare results in people with what is known about dolphins" (ATSDR, 2014b)?

Does the ATSDR study imply what is known about dolphins could be utilized to predict impacts to people eating the same fish species (ATSDR, 2014b)?

Did ATSDR report, "We did find that human and dolphin specimens contain qualitatively similar environmental contaminants" (ATSDR, 2014b)? Does this statement imply the dolphin data is very important to understanding chemical exposure to people from the LCP Site?

What are the implications to the HHBRA from the BERA not having included the dolphin data and studies identified in these comments to the EPA on the BERA?

The BERA and Dioxin/Furan

The BERA States:

> Dioxins/furans were collected from three sediment samples in October 2000 at C-6, C-8, and C-15 in the LCP estuary. Two additional samples were collected from the Troup Creek and Crescent River reference stations. Using the mammalian toxicity equivalency factors for each of the dioxin/furan congeners (U.S. EPA, 2008a), the toxicity equivalence concentrations (TECs) at the LCP estuary stations ranged from 54 ng/kg to 1,878 ng/kg. At the two reference stations the dioxin TEC concentrations were less than 10 ng/kg. The EPA Region 4 sediment screening-level for dioxins is 2.5 ng/kg which are based on the most toxic form of dioxin (2,3,7,8-tetrachlorodibenzo-p-dioxin [TCDD]). The maximum concentration of TCDD in the reference samples was 1.7 ng/kg while the highest concentration of TCDD from the three estuary samples was 53.7 ng/kg at C-6. Therefore, dioxins/furans are of concern. However, no further sediment or biota samples were analyzed for dioxins/furans during the monitoring program. **Therefore, potential risk cannot be adequately evaluated in this assessment based on the three sediment samples collected in 2000, but will be discussed further in the uncertainty section. (emphasis added)**

Are the TECs (a.k.a TEQ) reported 2 to 4 orders of magnitude higher than the EPA screening level of dioxin of 2.5 ng/kg?

Was any effort whatsoever made by the EPA to obtain existing dioxin/furan data from the St. Simons Sound in which the LCP Site is located?

Did the EPA ask Stakeholder Agencies if they had collected Dioxin/Furan data for the St. Simons sound estuarine system?

Did the EPA take into consideration the Dioxin/Furan sampling of Southern Flounder and Black Drum (both whole and filet) in Turtle River in 1989 (GADRN, 1989)?

Did the EPA take into consideration the Dioxin/Furan sampling of Southern Flounder, Black Drum. Sheephead, and Hardhead Catfish (filet) in Turtle River in 1990 (GADRN, 1990)?

Did the EPA take into consideration the Dioxin/Furan sampling of Southern Flounder, Black Drum. Sheephead, (whole and filet) in Turtle River in 1991 (GADRN, 1991)?

Did the EPA take into consideration the Dioxin/Furan sampling of Southern Flounder, Atlantic Croaker, and Gafftopsail Catfish (whole and filet) in Turtle River in 1992 (GADRN, 1992)?

Did the EPA take into consideration the Dioxin/Furan sampling of Southern Flounder, Black Drum, and Hardhead Catfish (whole and filet) in Turtle River in 1993 (GADRN, 1993)?

Did the EPA take into consideration the Dioxin/Furan sampling of Southern Flounder, and Stripped Mullet, (whole and filet) in Turtle River in 1993 (GADRN, 1993)?

Did the EPA consider the four samples for Dioxin/Furan taken in the Altamaha Canal south of the LCP Site in 2011 with results above the 2.5 NG/KG TEC (a.k.a TEQ) of 62, 130, 68, and 20 ng/kg (EPA, 2011)?

Did the EPA consider the December 1995 EPA Community Based Environmental Project's 14 sediment samples from the Turtle River/St. Simons Sound area?

In light of all the above Dioxin/Furan sampling conducted by the EPA or one of the LCP Chemicals Superfund Site Stakeholder agency, why should anyone, or the court who considers the Consent Decree, believe the EPA when it states, "Therefore, potential risk cannot be adequately evaluated in this assessment based on the three sediment samples collected in 2000, but will be discussed further in the uncertainty section"?

The EPA has interjected data from the lake Onondaga LCP site located near Syracuse, New York, into the Proposed Plan for the LCP site in Brunswick Georgia. Unlike the LCP site located in Brunswick Georgia, there was a significant amount of dioxin data collected at the LCP site located in New York (USEPA, 2002).

Was whole fish sampling for dioxin and furan in juvenal and adult fish conducted at the LCP site in Brunswick Georgia, or only at the Lake Onondaga Site?

Do the dioxin and furan sampling at the Lake Onondaga site in New York find a risks to wildlife from dioxin and furans (USEPA, 2002)?

If the risk from wildlife from dioxin and furans was found at the Lake Onondaga site, with those risks be applied to the wildlife at the LCP site in Brunswick Georgia? If not, why not?

If the EPA is using data from the Lake Onondaga Site for decision-making concerning sampling of dioxin and furan at the LCP site in Brunswick Georgia and to delay such sampling until after the Record of Decision and Consent Decree, why not use the same reasoning to utilize the data for estimating risk in Brunswick from the observations at the New York site?

Will the EPA order whole fish sampling for dioxin/furan in juvenal and adult fish from Turtle River to obtain the same quality data as used at Lake Onondaga, New York?

> "In mammals, learning behavior and development of the reproductive system appear to be among the most sensitive effects following prenatal exposure. In general, the embryo or fetus is more sensitive than the adult to dioxin-induced mortality across all species (ATSDR, 1998c, U.S. EPA, 1994a).
> Environmental exposure to dioxins includes various mixtures of CDDs, CDFs, and some PCBs. These mixtures of dioxin-like chemicals cause multiple effects that vary according to species susceptibility, congeners present, and interactions." (USEPA, 1994a)

Did the BERA include the dioxin and furans within the Turtle River area in their calculations for PCBs, dioxins, and furans TEQ or the hazard quotient or the hazard index?

<u>Manatee</u>

The Manatee, and endangered and protected species, is mentioned in the BERA but none of the work recommended by the US Fish and Wildlife Service (USFWS) has been completed. Again, the recommended work was centered on the keystone plant species in the LCP marsh, Spartina.

Did the USFWS find a need to examining the roots and note cleaning of the Spartina could result in an underestimation of the exposure scenario of herbivores like the Manatees, and the others in residents year round (USFWS, 1996)?

What was the EPA's rationale for not including the Manatee in the Baseline Ecological Risk Assessment?

Is EPA aware that the Manatees is an endangered and protected species?

What action is the EPA taking at the LCP Chemicals Superfund site to assure the Manatee is not consuming excessive amounts of PCBs, mercury, and dioxin via the cordgrass (Spartina)?

Did the EPA make an estimation about how much sediment the Manatee would consume while foraging on the cordgrass (Spartina)? If not why not?

Diamondback Terrapin

Early in the examination of the LCP Chemicals Superfund Site for ecological damage the diamondback terrapins were examined. The terrapins were found to be suffering from wasting syndrome and reproductive problems. The BERA appears to have drifted away from the empirical evidence presented to modeling impacts.

In light of the wasting syndrome reproductive problems identified with the Terrapin, how did the BERA come to the conclusion that there is a hazard index or hazard quotient less than one?

Is it possible to have reproductive failure and a hazard quotient or hazard index less than one?

Is it true that the levels of PCBs observed in the Terrapin eggs was in excess of 600 ppm (USEPA, 1997)?

Were the eggs examined for reproductive viability?

What were the results of the examination of the Terrapin eggs for reproductive viability?

Will the Terrapin be included in the species used for monitoring and evaluating the remedial action efficacy?

Human Health Baseline Risk Assessment Comments and Questions

The only appropriate way to start the review of the Human Health Baseline Risk Assessment is with the following two quotes from studies that do, unlike the EPA or the Potentially Responsible Parties, fully realize the serious and dangerous situation facing people residing around the LCP Chemicals Superfund Site, the need to evaluate the dolphin data, studies and reports; and, in particular anyone consuming seafood from the St. Simons Sound estuarine system.

> "Moreover, PCB signatures in dolphin blubber closely resembled those in local preferred prey fish species, strengthening the hypothesis that inshore T. truncatus populations exhibit long-term fidelity to specific estuaries and making **them excellent sentinels for assessing the impact of stressors on coastal ecosystem health** (Pulster, 2008)".

> "The severity of the effects suggests that the PCB mixture to which the Georgia dolphins were exposed has **substantial toxic** potential and further studies are warranted to

elucidate mechanisms **and potential impacts on other top-level predators, including humans, who regularly consume fish from the same marine waters** (Schwacke, 2011)."

When reviewing the Human Health Baseline Risk Assessment (HHBRA) is important to keep in mind the saying "garbage in garbage out". In case of the HHBRA, there was plenty of garbage to go around. But in spite of the tendency to make light of how bad the document is, the ramifications to Glynn County and the surrounding Brunswick community are real, serious, and have significant ramifications to the future health and welfare of the citizens of Glynn County, and anyone from the surrounding coastal Georgia Counties catching and consuming seafood from the contaminated areas. Furthermore, the area of contamination delineated appears incomplete and limiting the remedial activities the site property boundaries could be grossly inadequate. The failure to produce a viable document is a real threat to human health. Like the Baseline Ecological Risk Assessment, what is missing from the report is more notable than what is in the report. In addition to the dismal quality of the report, the EPA has a long history of less than competent efforts to protect human health and the environment around the LCP Chemicals Superfund site for the past 20 years. This indicates the EPA has never had a firm grasp on the seriousness of the problem at the LCP Chemicals Superfund Site. Further aggravating the problem is the numerous changes in s EPA Remedial Project Managers, which is not meant to reflect on the character of the Remedial Project Managers but rather another indicator of the EPA management's inability to put a lucid and comprehensive plan together for the LCP Chemicals Superfund Site and move the cleanup ahead in a timely manner.

Numerous action items were identified for the EPA to implement in the Brunswick, Glynn County, community to protect people from the risks from the LCP Chemicals Superfund Site. These include, but not limited to, following recommendations from the Agency for Toxic Substances and Disease Registry (ATSDR, 1994, 1996, 1999, 2014):

- Raise awareness about the fishing advisories among residents and healthcare providers.
- Improve the fishing advisory signs so that they are more easily seen.
- Maintain the fishing advisory until the source of contamination is removed.
- Continue public education regarding the hazards of consuming Mercury contaminated seafood with a focus on pregnant and nursing women, children, the elderly, and those with compromised immune systems. Evaluate the feasibility of developing a fact sheet based on the Georgia DNR guidelines for eating fish from Georgia waters, specific for fishing areas in Glynn County to be made available were fishing licenses are sold.

What programs has the EPA implemented to raise awareness about fishing advisories among residents and healthcare providers?

What were the dates of the EPA initiatives to raise awareness with health care providers about the seafood advisories?

What improvements did the EPA make to the fishery advisory signs so they are more easily seen?

How many fish advisory signs has the EPA had placed in the community?

Where are the fish advisory signs the EPA has placed in the community located?

What is the EPA's budget for fish advisory signs?

What is the EPA's budget to maintain the fish advisory until the source of contamination is removed?

What is the EPA's budget for continuing public education regarding the hazards of consuming mercury and PCB contaminated seafood?

How does the EPA focusing on pregnant and nursing women, children, the elderly, and those with compromised immune systems?

The EPA answering the above questions is critical in evaluating the Feasibility Study since institutional controls are be considered for protection of human health. The EPA's performance over the past 20 years in implementing recommendations protective of human health will be a very good indicator of what can be expected moving forward. Indications are the EPA is inept and does not have the management continuity to implement or manage a competent program of institutional controls. Therefore, at a minimum, the EPA should appropriate sufficient funding to have the appropriate actions implemented on the local level for as long at the threat from contaminated seafood remains.

Will the EPA require an appropriation or appropriate funding to implement the already identified activities to better protect human health and the environment?

Will the EPA expedite the appropriation of funds to implement the recommendations intend to help protect human health?

The stated goal of the HHBRA is: The overall goal of this risk assessment is to develop essential scientific information that can be used in decision-making regarding the LCP Chemicals Site estuary in support of an evaluation of the need for remedial action.

The guidelines for seafood sampling utilized for the HHBRA state:

> "For scaled fish, fillets should be scaled but left with the skin on. For fish without scales, the skin should be removed from the fillet " (GA-DNR) (FTAC, 1992).

Are the fish samples collected from Turtle River being prepared according to the appropriate protocols and the skin and belly flap left on the filet?

Was whole fish sampling conducted in order to determine the range of exposures human consumers might encounter?

> "For the fish consumption risk assessment, both RME and CTE exposure assumptions (Table 10) were developed from USEPA (1997a) and other sources (DHHS, 1999; Appendix B)."

Agency for Toxic Substances and Disease Registry (ATSDR) Public Health Assessment (PHA) found the 1999 Department of Health and Human Services (DHHS) report on seafood consumption from the turtle River area to be inappropriate for estimating risk to the African-American population in Brunswick and Glynn County Georgia. Specifically, ATSDR noted:

> "And finally, it should be noted that African-Americans made up only 4% (9 out of 211) of the people who participated in the study. African-Americans make up 26% of the population of Glynn County and nearly 40% of the population within four miles of the LCP Chemicals Site. Therefore, African-Americans are underrepresented in the Brunswick fish study.
> A study of fishers along the Savannah River showed that African-Americans
> • Eat more fish meals per month than whites (average, 5.4 vs. 2.9),
> • Eat slightly larger portions than whites (average, 13.7 oz. vs. 13.1), and
> • Eat higher amounts of fish per month than whites (average, 75 ounces vs. 41 ounces).
> It is reasonable to assume that the fish-eating habits of African-Americans in Brunswick, Georgia, are similar to African-Americans along the Savannah River. Therefore, African Americans who fish along the Turtle River are likely to have higher exposure to mercury from eating fish than whites. The results of the Brunswick fish study should not be applied to African Americans in the Brunswick area for those reasons." (ATSDR, 2014a)

Notable is that the EPA's own database found 72% the population within 1 ½ miles of the LCP site reported their race as black, or African American. In addition based on reported 1999 household income 32% reported under $15,000, and 18% under $25,000 (EPA, 2015).

The authors of the HHBRA put great weight in the average yearly income of the coastal Georgia residents in evaluating seafood consumption patterns. The HHBRA reports the average yearly income of coastal Georgia ZIP Codes as being $38,193. Obviously the EPA's own data indicates the actual income level of over 50% of the people is less than half that was what is reported in the report. The HHBRA stated:

> "There were very few consumers of Striped Mullet and Spot. Census data can provide the average income per zip code. The average income of the zip codes of anglers harvesting Spot and Striped Mullet were obtained from databases maintained by the Missouri Census Data Center (MCDC, 2006). The average yearly income of the zip codes of the coastal Georgia residents harvesting Spot from 2001 to 2005 was $35,240. The average yearly income of the zip codes of the coastal Georgia residents harvesting Striped Mullet from 2001 to 2005 was $37,847. The average yearly income of all the coastal Georgia zip codes was $38,193. These income values seem quite similar."

Did the EPA review their own demographic data for the area around the LCP Chemicals Superfund site when reviewing the HHBRA (EPA, 2015)?

Did the EPA advise the authors of the HHBRA that they could find more accurate demographic data and household income data on the EPA's website (EPA, 2015)?

Is obvious the authors of the HHBRA were struggling to find data. Even data points of the single fishermen appeared to be important to them. It is obvious the authors were struggling to find demographic data. As noted in the HHBRA:

> "It is interesting to note that of the group of nine anglers who harvested Spot from 2001 through 2005, **only one came from Brunswick** (emphasis added) whereas four came from Savannah. The average zip code income of this single Brunswick angler was $23,898. The average zip code income of the Savannah anglers ranged from $18,830 to $60,182. In addition, there may be income variability within a single zip code but income data for smaller areas are not available."

And,

> "It is possible that some subsistence anglers lived in the Savannah zip code in which the average income was $18,830. However, none of these anglers were from the Brunswick area and there remains no evidence that there were subsistence anglers in the Brunswick area."

If the authors of the HHBRA were using income as an indicator of whether fishermen were or were not subsistence anglers, 32% of people living within 1 ½ miles of the LCP Site having an annual household income of under $15,000 would have been very significant and the only conclusion that could be made is that there are a very significant number of subsistence fishers in Brunswick, Georgia, based upon the metrics utilized in the HHBRA.

Will the EPA utilize the income data from their website to modify the HHBRA to indicate there's a high likelihood of a significant numbers of subsistence fishers within close proximity to the LCP site?

Over and over the authors of the HHBRA utilize data from a relative small number of people. They found two Glynn County residents identifying themselves as subsistence fishers as being significant. As noted in the HHBRA:

> "Appendix B of the HHBRA - Because the ATSDR/GCHD seafood survey (DHHS, 1999) included two Glynn County residents who identified themselves as "subsistence" fishers, this risk assessment included an evaluation of hypothetical high quantity consumers of fish."

It was obvious while reading the HHBRA that the authors were going to great extent to disprove through data on income and demographics that they were not subsistence fishers. Long and detailed discussions about what was or was not a subsistence fish filled the HHBRA. It was obvious the authors lost site of the purpose of the HHBRA and that is to establish the likely amount in seafood being consumed by the local population. Furthermore the HHBRA should utilize ecological data as an indicator of potential impacts to human health and the environment. The BERA appeared to selectively exclude data that would have provided the needed information through sentinel species such as dolphins. But the plight of the dolphins and its implication to human health and the environment is not lost on researchers in coastal Georgia (Schwacke, 2012). A great deal of research and study has been conducted on the resident dolphin population. The extremely high levels noted in the dolphins led to significant concerns about the human population consuming seafood in coastal Georgia. Sampling of nine humans did take place in the area of Sapelo Island and the results were reported to the personnel from stakeholder agencies and the EPA Remedial Project Managers working on the LCP Chemicals Superfund Site (ATSDR, 2014b). Without doubt the presentation was about the LCP Site since it specifically mentioned the LCP Site 25 times. Also notable is the authors of the HHBRA use the same dolphins studies that were used to link the PCBs found in humans to the LCP Site to define Aroclor 1268 (Pulster, 2005; Pulster 2008). Actually, the studies quoted by the HHBRA authors unequivocally identified the signature as being linked with the LCP site and noted his potential to harm human health and the environment.

> "Legacy organochlorine (OC) contaminants continue to pose a **potential risk to ecological and human health in coastal aquatic ecosystems of the southeastern United States."** (Pulster, 2005)

Does the EPA agree that the definition of Aroclor 1268 presented in Pulster, 2005 and Pulster, 2008 was used in the HHBRA to define PCBs associated with the LCP site?

Does EPA agree that the same PCB profile described in Pulster, 2005 and Pulster, 2008 was used to define an associate the PCBs found in humans sampled in the Sapelo Island area (ATSDR, 2014b)?

The September 3, 2014 presentation, *Polychlorinated Biphenyls (PCBs) in Georgia Coastal Environments and Populations,* to provide helpful information about the quantities of fish consumed in coastal Georgia. Based upon the surveyed fishermen, the appropriate annual number of seafood meals to be utilized for calculations in the HHBRA would be 156 (3 meals per week X 52 weeks = 156 meals per year) rather than the 40 utilized for risk-based calculations in the HHBRA. Notable is the 8 of the people sampled were from a community of 195 people and represent over 4% of the population. The high consumption consumer might exceed 156 meals per year the EPA should consider a greater number of meals per year than 156.

Will the more current data (ATSDR, 2014b) collected in coastal Georgia rather than the discredited data that's now 20 years old (DHHS, 1999)?

Will the EPA set the annual number of seafood meals consumed by the high quantity consumer at 156 or higher?

Will the EPA increase the size of the meal to reflect those consumed by African-Americans as reported in the Public Health Assessment (ATSDR, 2014a)?

As noted in real world survey of coastal Georgia fish consumers, the following consumption habits were documented (ATSDR, 2014b). The actual seafood consumption habits are far different the assumptions used in calculating risk, which were based upon filets only, and did not consider fish egg (roe) consumption.

- Filet with skin removed -11%
- Filet with skin on – 33%
- Whole fish (gutted) – 56%
- Whole fish (not gutted) – 11%
- Fish eggs – 44%

The cultural habits and preferences for seafood preparation and consumption are discussed further in the section - Feasibility Study Comments and Questions.

A considerable effort was made to obtain the sampling results and the reported high and low level of total PCBs observed in the nine sampled human subjects (ATSDR, 2014b). The numerical total PCB data in conjunction with the total PCB data from fish and shellfish could be utilized to better set maximum health-based remedial action goals. Good data is critical to accurate assessments through the calculations used to determine risk and set remedial action goals protective of human health and the environment. Even though quantitative results were presented at the September 3, 2014 meeting, the CDC and the agencies involved in producing the data have refused to provide the information critical to formulating a robust and protective cleanup plan and remedial action. Therefore, it became necessary to submit a Freedom of Information Act (FOIA) request to the Center for Disease Control (CDC). The FOIA was submitted in a timely manner that the CDC has been excessively recalcitrant and resistant to releasing any data. An Expedited Processing Request was submitted due to the limited time provided to submit comments to the EPA on the Proposed Plan for the marsh at the LCP site. At this time, it appears the EPA public comment period on the proposed plan will close without the requested data being received for inclusion two in the public participation and comment phase of the proposed plan decision-making process. At this time it is the intent of the Glynn Environmental Coalition to continue efforts to obtain the data critical to a robust and protective Proposed Plan, Remedial Design, and Remedial Action in the LCP marsh. Furthermore, the Glynn Environmental Coalition may exercise its right to challenge the Consent Decree when entered before the court and request the data be incorporated into the Proposed Plan, Record of Decision, and the Consent Decree.

The history of the effort of the Glynn Environmental Coalition to obtain the high and low levels of total PCBs observed in the human sampling study follows:

- September 3, 2014: ATSDR presentation "Polychlorinated Biphenyls (PCBs) in Georgia Coastal Environments and Populations" takes place.
- October 17, 2014: FOIA request to CDC/ATSDR for the underlying data, reports, or other information concerning Polychlorinated Biphenyls (PCBs) in Georgia Coastal Environments and Populations, presented on September 3, 2014, by the Health Studies Branch, by Lorraine Backer and David Mellard, National Center for Environmental Health Eastern Branch, Agency for Toxic Substances and Disease Registry.

- October 22, 2014: FOIA responds acknowledging receipt – informs that they will not be able to comply within the 30 days max provided by statute (20 business days plus ten day extension).
- November 7, 2014: Glynn Environmental Coalition contacts FOIA in effort to speed up process. "Due to the need for a prompt response to Request Number: 15-00080-FOIA, we request communications concerning any charges be made via email or arrangements for pre-payment be arrange to avoid any delays."
- November 14, 2014: Update from CDC on progress of request.
- November 25, 2014: Glynn Environmental Coalition emails CDC to narrow request in effort to expedite response; Concerning the Study presented. The scope of the request can be narrowed to:

- The study Methods
- Individual analytical results with identifying information redacted
- Study maps
- Abstract or Summary Report
- Full report w/o identifying information about the participants
- References and bibliography

CDC acknowledges receipt and revised request was sent to appropriate program office for a new search – refused to provide date by which request would be completed.

- December 19, 2014: Glynn Environmental Coalition calls CDC re: FOIA request.
- January 6, 2015: Letter from CDC stating amended request was still being processed, that CDC is under backlog, and CDC cannot give a timeframe for when request would be completed.
- January 26, 2015: Glynn Environmental Coalition officially requests expedited processing for the request.
- February 2, 2015: CDC denies expedited processing request and 30-day appeal process begins.
- February 20, 2015: Appeal of denial for Expedited Processing sent to CDC FOIA Office.
- February 24, 2015: CDC Acknowledgement of Receipt of Administrative Appeal
- March 16, 2015: EPA public comment period expires on the LCP Chemicals Superfund Site Proposed Plan.

Extensive contamination of the turtle River area with dioxin and furans has been documented over a number of decades but is noticeably missing from the HHBRA. Failure to collect dioxin and furan data over a 20 year at the LCP site strains the credibility of EPA management and those conducting the investigation of the site. The EPA has clear and specific guidance for assessing risk from sites with chemicals with dioxin like and non-dioxin like risks such as PCBs and assessing the carcinogenic and non-carcinogenic risk (EPA, 2000).

> "Therefore, separate risk assessments should be conducted for the dioxin-like and nondioxin-like PCB congeners if the congener analysis indicates elevated concentrations of dioxin-like congeners relative to the typical commercial mixtures (IRIS, 1999; U.S. EPA, 1996c).
>
> Therefore, failure to evaluate the dioxin-like PCB congeners could result in underestimating cancer risk.

Dioxins have been shown to cause adverse developmental effects in fish, birds, and mammals at low exposure levels. Several studies in humans have suggested that dioxin exposure may cause adverse effects in children and in the developing fetus.

In mammals, learning behavior and development of the reproductive system appear to be among the most sensitive effects following prenatal exposure. In general, the embryo or fetus is more sensitive than the adult to dioxin-induced mortality across all species (ATSDR, 1998c, U.S. EPA, 1994a).

Environmental exposure to dioxins includes various mixtures of CDDs, CDFs, and some PCBs. These mixtures of dioxin-like chemicals cause multiple effects that vary according to species susceptibility, congeners present, and interactions.

Risk assessment of these complex mixtures is based on the assumption that effects are additive and there is some experimental evidence to support this (U.S. EPA. 2000).

Organochlorine pesticides, PCBs, dioxins/furans tend to concentrate in fatty tissues (Armbruster et al. 1989; Branson et al., 1985; Bruggeman et al. 1984; Gutenmann et al. 1992; Kleeman et al., 1986a, 1986b; Ryan et al., 1983; Skea et al., 1979; Sanders and Hayes 1988; U.S. EPA, 1995a). Many of these compounds are neither readily metabolized nor excreted and thus tend to biomagnify through the food web (Gardner and White, 1990; Lake et al., 1995; Metcalf and Metcalf, 1997; Muir et al., 1986; Niimi and Oliver, 1989; Oliver and Niimi. 1988; U.S. EPA, 1995a)."

Will the EPA utilize existing dioxin and furan in fish data and incorporated into the HHBRA risk analysis (GA DNR, 1989; GADNR, 1990; GADNR 1991; GADNR, 1992; GADNR, 1993; GADNR, 1994)? If not, why not?

Remedial Investigation Comments and Questions

The Remedial Investigation (RI) appears to present opining and unsubstantiated statements of fact. The quantity and quality of the data used in the RI appears to have flawed the remaining site documents. Significant data gaps need filling before a viable RI/FS can be produced for the LCP Site. As previously noted in comments from the stakeholder agencies, quantity of data should not be confused with quality of data.

8.2.3.2.2 Fish Consumer Scenarios

"The fish consumer scenarios are used to evaluate potential exposure to COPC in fish caught in areas of the estuary proximate to the LCP Site. Fish Consumption Guidelines (FCGs) have been established by GADNR for these areas (GANDR 2011) and these FCGs are made available to the public via the GADNR website. GADNR **also posts signage in areas subject to the FCGs to advise anglers about the potential hazards**

> **associated with consuming fish and shellfish from these areas.**(emphasis added) .... The recreational fish consumer scenario is used to evaluate exposure to recreational anglers who consistently consume fish from the LCP estuary over a long period of time (e.g., 26 meals per year for 30 years for adults). ..... The high quantity fish consumer scenario is used to evaluate exposures to individuals who consume more locally-caught fish than the typical recreational angler (e.g., 40 meals per year for 30 years for adults)."

How many signs have been posted by the GADNR in the area and where are the signs located?

Has the high quantity fish consumer meal assumption of 40 meals per year been discredited (ATSDR, 2014a)?

Are a more appropriate number of meals for the high quantity fish consumer closer to 156 per year (ATSDR, 2014b)?

<u>8.2.3.2.3 Shellfish Consumer Scenario</u>

> "The shellfish consumer scenario is used to evaluate potential exposure to COPC in shellfish (e.g., white shrimp and blue crab) caught in areas of the estuary proximate to the LCP Site. As described above for fish, GADNR also develops FCGs for shellfish. The shellfish consumer scenario assumes consistent and long-term consumption of shellfish directly from the LCP estuary (e.g., 19 meals per year for 30 years for adults). This scenario uses data on the amount of shellfish fish consumed by children, adolescents, and adults in the United States (EPA, 1997a)."

Does the EPA actually believe the data presented in the RI for shellfish consumption in light of catching crabs and casting for shrimp being recreational activities in coastal Georgia?

Has either the EPA or the Responsible Parties noticed all the docks along Turtle River and the crab trap lines extending onto the water?

Did the authors of the RI make any attempt to observe seafood harvest and consumption patterns along the Georgia Coast or are all the assumptions in the RI averages of the entire population of the United States?

Is the EPA aware of just how dangerous applying data from national consumption pattern is when determining risk to a local population from a locally contaminated food source?

What does the FDA recommend to do when a locally contaminated food source is encountered?

8.2.6 Characterization of Uncertainties

"… posted signage generally serve to discourage the consumption of significant amounts of seafood from the area, particularly given the number of meals assumed to be eaten consisting of fish caught in the LCP estuary;"

What is the study cited in support of the conclusion "….posted signage generally serve to discourage the consumption of significant amounts of seafood from the area…"?

Are the authors of the RI citing a study or opinion when they state "….posted signage generally serve to discourage the consumption of significant amounts of seafood from the area…"?

What is the definition of the LCP estuary and what are the geographical boundaries?

Is the "LCP estuary" defined by the extent of contamination from the LCP Site in coastal Georgia?

Does the Georgia Department of Natural Resources seafood consumption advisories encompass the entire "LCP estuary"?

Have any agencies questioned the need to extend the extent of seafood consumption advisories due to the spread of contamination from the LCP Site (ARSDR, 2014b)?

Have any recommendations or suggestions been made concerning expanding the sampling and analysis in the ecosystem and humans to more fully identify the extent of LCP Site contaminants spread (ATSDR, 2014b)?

8.3.3.4 Chemicals of Potential Concern (only mention of dioxin in the RI)

"Several additional organic chemicals were detected in a small number of samples at concentrations above the conservative EEVs, including dichlorodiphenyltrichloroethane (4,4'DDT), dioxin/furan congeners, bis(2-ethylhexyl)phthalate, 3,4-methylphenol, butylbenzylphthalate, and hexachlorobenzene. These chemicals are not quantitatively evaluated for benthic or food chain risks, but are discussed qualitatively in the OU1 BERA."

Were the chemicals detected in a small number of samples or were they identified for analysis in a small number of samples?

How many samples were taken in the LCP Site marsh, and how many were specified for dioxin and furan analysis?

What is the difference between qualitative and quantitative when establishing risk in a document like the BERA?

How was risk established through a qualitative discussion of dioxin and furan in the BERA?

Did the quality and completeness of the sampling and analysis for dioxin and furan in the RI a hindrance to evaluating risk in the BERA and HHBRA?

8.3.5.8 Piscivorous Mammals (Assessment Endpoint 7)

> "One LOE was used to evaluate the viability of piscivorous mammals foraging within the LCP estuary: HQs derived from food-web exposure models for river otters. The following is a summary of the findings:
>
> • The modeling study for river otters generated Site NOAEL HQs for Aroclor-1268 (based on a TRV for Aroclor 1254) that ranged from 0.1 to 3.9. No LOAEL-based HQ for Aroclor-1268 exceeded 1. In addition, no risk of adverse effects was predicted for mercury or lead exposures. Based on these findings, the BERA Report concluded that the potential risk to the viability of piscivorous mammalian species utilizing the LCP estuary is minimal."

Would the conclusion "....BERA Report concluded that the potential risk to the viability of piscivorous mammalian species utilizing the LCP estuary is minimal" if the dophin data was added to the BERA (Balmer, 2011; Balmer, 2013a; Balmer 2013b; Hart, 2012; Hickie, 2013; NOAA, 2013; Pulster, 2005; Pulster, 2008; Schwacke, 2012)?

What impacts to dolphin health were found in the studies (Balmer, 2011; Balmer, 2013a; Balmer 2013b; Hart, 2012; Hickie, 2013; NOAA, 2013; Pulster, 2005; Pulster, 2008; Schwacke, 2012)?

Were the health effects found in dolphins "minimal" (Balmer, 2011; Balmer, 2013a; Balmer 2013b; Hart, 2012; Hickie, 2013; NOAA, 2013; Pulster, 2005; Pulster, 2008; Schwacke, 2012)?

Were the chemicals found in the dolphins linked to the LCP Site (ATSDR, 2014b)?

Would the EPA find the absence of an indigenous species like the mink from the LCP Site significant?

Would the absence of a viable mink population indicate there is a dead zone where mink cannot survive around the LCP Site?

Would a dead zone where mink cannot survive be described by the EPA as "minimal risk"?

Would the EPA agree that the observations in the dolphin population indicate the models referenced in the RI are significantly flawed and do not agree with the observed ecological impacts? If not, why not?

What is the definition of "minimal risk" used in the RI?

Does the empirical evidence documented prove the models in the BERA and RI do not hold up when compared what is known about ecosystem on the Georgia coast and the impacts from the chemicals associated with the LCP Site (Balmer, 2011; Balmer, 2013a; Balmer 2013b; Hart, 2012; Hickie, 2013; NOAA, 2013; Pulster, 2005; Pulster, 2008; Schwacke, 2012, ATSDR, 2014b)?

Feasibility Study Comments and Questions

The Feasibility Study (FS) could not be fully evaluated for a number of reasons. Most frequently, there was an insufficient amount of information or the technologies previously identified for consideration by the stakeholder agencies were not carried through the FS evaluation process. Much of the data utilized over the 20 years the FS was produced became outdated or otherwise discredited. More current data was produced about the state and condition of the ecosystem, cultural seafood consumption preferences, and demographics of the populations most impacted from the Site. To a large extent, the current data was not incorporated into the LCP site documents, and therefore not utilized in the FS. The FS became dated, lost continuity of process over the extended number of years, and otherwise became disconnected with the realities of Site conditions and the surrounding community.

Significant deficiencies identified in the FS were:

- The seafood consumption data underlying risk calculations was discredited by ATSDR and new data became available to evaluate human exposure to Site COCs (ATSDR, 2014a; ATSDR, 2014b). The appropriate meals per year number appear to be closer to 156 than the 40 previously used. The assumption that people consume only the fish filet appears to be wrong, also. The recalculation of risk and cleanup goals could significantly change the scope of work and the technologies considered for remediation.

- Dioxin and furan chemicals were not tested for, nor did the LCP Site documents include available data. Without inclusion of the dioxin and furan data, an accurate risk assessment and remedial action plan cannot be completed. It appears the FS is based upon assumptions and not data concerning dioxin and furan, and ignores these chemicals would be additive to the cancer and non-cancer risks associated with PCBs due to the similar structure of the molecules and similar modes of action. Without the dioxin and furan data, the risk calculations can only be assumed to grossly understate the actual risks. Furthermore, with the addition of the observation that toxicity tests found unexplained levels of toxicity in the sediments, the incompleteness of the COC list might extend beyond dioxin and furans. At a minimum, the cleanup should be driven by the observed toxicity (empirical data) and not the modeling data. Empirical data <u>always</u> trumps modeling data. Modeling data should <u>always</u> be compared with the empirical data to assure the model holds up to real world conditions at the Site. When sampling and analysis fail to identify the toxic compounds, the observed toxicity should drive the remedial decision-making.

- Technologies utilizing coffer dams, sheet piling, or other methods of confining sediments during remedial activities were not evaluated, even though the stakeholder agencies had identified these as preferred (NOAA, 2000). Furthermore, utilizing a containment structure and dry excavation method would have resulted in very significant changes in the approach to the remediation. 1.) Remedial Action mobilization and access to the marsh would have been from the uplands. 2.) "Marsh Disturbance Beyond Remedy (acres)" would have been minimized, as would the potential to re-suspend COCs and distribute throughout the marsh or remediated areas. 3.) The project could be accessed from a single access point and single decontamination of equipment point established. 4.) Technologies using other than dredging could have been evaluated and implemented. Notable is coffer dams were previously used at the LCP Site during the EPA Emergency Response and Removal. The proposed remedial activities adjacent to the existing coffer dam and can be accessed from these previously remediated areas, and new temporary coffer dam structure could be built off of the existing structures.

- Areas identified as Marsh Disturbance Beyond Remedy (acres)" were not described in the FS. While the authors of the FS argue minimal disturbance is needed to preserve the marsh ecosystem, the technologies selected and the methods of implementation are prone to marsh disturbance, and all proposed remedies "disturb" more acreage than is being remediated. Significant potential to disturbed COC contaminated sediments exists but could not be evaluated due to these areas not being identified.

- The source areas were not sufficiently described and significant data gaps were evident, including but not limited to the following:

    - Spartina was not analyzed, investigated, or evaluated as a source of COCs in the marsh. Spartina is the base of the marsh food chain, known to bioaccumulate COCs present from the LCP Site, and appears to be intentionally avoided for remediation. Therefore, the FS appeared to be "fatally flawed" and detached from the realities of a Spartina-based marsh ecosystem.

    - The depth of sediment samples was less than the expected depth of COCs in the marsh. It appeared the sampling was conducted with a maximum remedial depth already determined.

- The depth of bioturbidation was not accurately described or quantified. The authors of the FS did not appear to grasp the importance of knowing and identifying the biota causing bioturbidation, the depth of disturbance, and the quantity of sediment brought to the surface on an annual basis. Particularly with remedies considering capping, fully quantifying bioturbidation and the potential impact to the remedy is crucial. The lack of any such evaluation of bioturididation strains the credibility of the FS and questions the FS authors understanding if a Spartina-based marsh ecosystem inhabited by burrowing biota.

- Keystone ecological species are missing from the documents used to develop the FS. These include mink, dolphin, manatee, and diamondback terrapin. Notable is the large volume of data available on the resident and transient dolphin population, which is conspicuously missing from the FS decision-making process (Balmer, 2011; Balmer, 2013a; Balmer, 2013b; Hart, 2012;

Hickie, 2013; NOAA, 2013; Pulster, 2005; Pulster, 2008; Schwacke, 2012). The LCP Site documents utilize the dolphin data to argue for sampling and analysis of only Aroclor 1268 with the dolphin studies, but failed to also realize the ecological impact or include this data in the BERA. The selective nature of data usage throughout all the documents supporting the FS is very noticeable.

- Noticeable is the FS does not contain measurable goals for assessing the recovery of the eco-system or a timeline to take goal measurements and conduct evaluations. Even more noticeable is the exclusion of the keystone species by which a remedial action would be assessed and the recovery measured. These species include mink, diamondback terrapin, and dolphin, and would cover mammal marine mammal, and reptile. An avian and herbivore indicator species should also be included. A full suite for seafood species should be analyzed on an annual basis, and whole, filet samples of juvenile and adult specimens collected and analyzed for a full suite of COCs. Dioxin and furan should be analyzed routinely at every sampling event and included on the COCs list.

- The FS does not identify actions to implement if the remedy fails to meet remedial goals on a set timeline. There is a three-part problem:

1. No measurable goals for the remedial action.
2. No timeline or measurement metrics for evaluating the remedial action.
3. No identified actions to be implemented if the remedial goals are not met by a specific date.

There were other indications the authors of the FS were significantly disconnected from the realities of the LCP Site, the conditions present on and around the Site, and in the community. These "disconnects" have the potential to be a significant threat to public health, and should not be taking lightly by the EPA or the community. When those charged with a cleanup upon which the public health and welfare is dependent show a profound lack of understanding of the situation, the EPA should move quickly and decisively to remove remedial activities from the Potential Responsible Parties and into the hands of a competent contactor. Furthermore, the EPA should order the contractor to move ahead with all due diligence and speed. The following are two examples of failures to understand the public health crisis at the LCP Site.

<u>Example One:</u>

> "All alternatives include institutional controls such as fish consumption advisories."

> "Providing information that helps modify or guide human behavior and enhance protectiveness at a site, such as notices, signage, and fish consumption advisories that maybe required until RAOs are met."

The FS authors suggest they can modify or guide human behavior to enhance protectiveness. Again, the authors are either disingenuous or delusional (or both) in making this statement. If human health could be protected in such a manner, the only responsible action would have been to implement these measures (information, notices, signage, and fish consumption advisories) immediately upon learning about the risk to human health. As previously noted in comments on the HHBRA, the EPA, Georgia Department of Natural Resources, and the Potentially Responsible Parties have failed, to implement the recommended action made by ATSDR over the past 20 years.

In light of the EPA, Georgia Department of Natural Resources, and the Potentially Responsible Parties failure to implement recommendations by the ATSDR to protect human health since issues 21 years ago, why should anyone believe any of these agencies or parties are capable or will now do so at this time?

Is it arrogant to suggest the Potential Responsible Parties have the power to guide or modify human behavior?

What evidence (studies or reports) are presented to suggest there has been any success in implementing Institutional Controls over the past 20 years?

What is the budget for implementing Institutional Controls until the cleanup goals are reached?

What has been the budget for these Institutional Controls over the past 20 years?

Example Two:

> **"Section F-1 Contents: Excerpt from GADNR Fish Consumption Advisory Threshold Memorandum**
>
> "This section is an excerpt from the GADNR technical memorandum identifying the dietary thresholds used by GADNR to establish fish consumption advisories for the TRBE. The edible fish and shellfish tissue data provided in Section F-3 are compared to these thresholds. These thresholds are not appropriate for comparing to the whole-body fish tissue data provided in Section F-4 **because anglers do not consume the whole-body fish samples, only the edible tissues."(emphasis added)**

As noted in real world survey of coastal Georgia fish consumers, the following consumption habits were documented (ATSDR, 2014b).

- Filet with skin removed -11%
- Filet with skin on – 33%
- Whole fish (gutted) – 56%
- Whole fish (not gutted) – 11%
- Fish eggs – 44%

It is clear the authors are interjecting opinion and not scientific fact into the FS for the sole purpose of reducing the apparent level of risk. Obviously, the real world scientific data from Coastal Georgia shows at least 56% of people eat the whole fish, and only around 11% eat fish in the manner described in the FS. Also noticeably missing from the LCP Site records are data about fish eggs, which are high lipid seafood prone to accumulating site COCs. Interestingly, fish eggs were sampled and the results reported in the 2008 ATSDR Health Consultation for the Arco Quarry (ATSDR, 2008). In addition to Aroclor 1268 being found in the fish eggs, it was present at a level an order of magnitude (X10) than in fish tissue. Other notable coastal Georgia delicacies are smoked mullet and mullet roe, which also deserve sampling and analysis for the Site COCs, and are noticeable missing from Site documents. But the point of the above discussion and data is to clearly identify the need to accurately identify the human health risks at the LCP Site and produce a FS that stands up to the real world facts as they are. Currently, the situation is an imminent risk to human health and the environment, and the EPA and PRPs have failed to produce a viable remedial plan to rectify the situation.

Does the EPA agree the authors of the FS are interjecting opinion with statement like, "because anglers do not consume the whole-body fish samples, only the edible tissues"?

Does the EPA agree that people in coastal Georgia do eat the whole fish, and not just the filet?

Does the EPA realize the fish eggs potentially have significantly higher levels of LCP Site COCs than the fish filet?

Did the FS or other LCP Site documents evaluate the consumption of fish eggs or other high lipid content seafood?

Was the EPA aware of the cultural seafood consumption practices in coastal Georgia such as fish eggs (roe), whole fish, and other methods of cleaning and preparation? If not, why not?

Would the findings about cultural seafood consumptions patters be significant and warrant inclusion in the HHBRA?

Proposed Plan Comments and Questions

The following comments are on the full Proposed Plan. The quote from the proposed plan is followed by the comment or question for the EPA to respond to in the Responsiveness Summary for the LCP Chemicals Superfund Site for Operable Unity One, the Marsh. In addition, as a community member and one of the persons who has used Purvis Creek for recreation, and intends to continue to use Purvis Creek for recreation, the area needs to be cleaned up, made safe for all uses, and the seafood be safe to catch and consume.

Introduction

> "The Plan summarizes information that can be found in greater detail in the RI/FS reports and other documents, which present the results of sampling conducted from 1995 through 2012."

Was there a compelling reason for the EPA to exclude data collected after 2012? Why not include data to date?

Site History

> "The Dixie Paint and Varnish Company operated a paint and varnish manufacturing facility at the Site from 1946 to 1956."

Honeywell contends in their Fact Sheet the paint contained Aroclor 1268. What documentation does the EPA have to support the contention that Aroclor 1268 was an ingredient in paints manufactured by Dixie Paint and Varnish Company?

Public Participation

> "The Region also publishes the quarterly *Brunswick Environmental Cleanup Newsletter* to update the public on the cleanup progress at the LCP Chemicals Site and the three other Superfund sites in the Brunswick area."

The Glynn Environmental Coalition is very concerned about the public participation process at the LCP Chemicals Superfund site. At the December 4, 2014 EPA public meeting Ms. Angela Miller, EPA Community Involvement Coordinator, stated that the mailing list for the LCP site have been deleted. In light of this statement please list the dates of the quarterly *Brunswick Environmental Cleanup Newsletter*, and the number of people the newsletter was sent to. In addition, I asked Ms. Miller why I had not received a copy of Proposed Plan via postal mail. Evidently this was due to the EPA community participation mailing list being deleted. Ms. Miller indicated that there was a considerable number of newsletters sent by the EPA being returned as undeliverable. During the same period, the Glynn Environmental Coalition (GEC) has been sending out Technical Assistance Reports (TAR) produced under the EPA Technical Assistance Grant (TAG) program for the LCP Chemicals Superfund site. Like the EPA, the GEC does receive a few newsletters back after each mailing, which we used to update the mailing list and keep the current as is required by postal regulations for organizations using a bulk mailing permit. By doing so we enable to maintain the continuity of the TAG mailing list even though many of the people have moved over the 18 years we've administered the TAG.

Please describe the EPA procedures for maintaining their community participation program for the LCP Chemicals Superfund site, including:

Does the EPA maintain a mailing list for the LCP Chemicals Superfund site?

Does the EPA use the returned newsletters to update the LCP Site mailing list?

If not, how does the EPA maintain the mailing list and keep it current, and maintain continuity in community participation at the LCP Site?

How many EPA quarterly newsletters have been sent out over the past three years at each mailing, and what were the dates of the mailings?

When the LCP Proposed Plan was released, how many were mailed to the community?

In light of the report from Ms. Miller that the LCP mailing list have been deleted, how did the EPA formulate the mailing list to send out the Proposed Plan?

Was the Proposed Plan sent to all the people who have signed up for on the EPA's mailing list for the LCP Site? If not, how many (what number) of the people who have previously signed up to the LCP Site EPA mailing list did not receive the Proposed Plan mailing?

What are the EPA's plans to assure future continuity in the mailing list for public participation at the LCP Chemicals Superfund site?

Is it possible for the EPA to recover the deleted mailing list and updated with returned newsletters or other mailings concerning the LCP Chemicals Superfund site, or other Superfund sites, in Glynn County?

How many addresses were on the list that was deleted?

Does the EPA keep a record of the Glynn County Superfund Site the person has signed up to receive information about from the EPA?

Can the EPA assure that there will be a mailing list maintained for the community participation in the decision-making process for the citizens of Glynn County from now and into the future, and will be available for the other propose plans and records of decisions that will be coming up for the Superfund sites in Glynn County?

The EPA provided the documents and materials in support of the LCP Chemicals Superfund Site Proposed Plan to the repository at the Brunswick Library on December 3, 2014. The EPA held their public meeting the following day on December 4, 2014. This resulted in giving the community one day to review 8700 pages. Taking into account the average work days eight hours, this would've left 3.3 seconds per page for the public to read the document. This does not include the time it would take to prepare comments for submittal at the EPA public meeting.

Does the EPA feel it is appropriate to allow 3.3 seconds per page for the public to read the documents the EPA provided?

How much time does the EPA feel is appropriate for the community to review 8700 pages, prepare comments, and be ready for the EPA Public Comment Meeting to submit comments to be taken down by a court recorder?

Was the purpose of releasing 8700 pages 24 hours before the Official EPA Public Comment Meeting to thwart any meaningful community comments at the Official EPA Public Comment Meeting?

How many requests for another EPA public comment meeting have been received by the EPA?

Have the Congressional representatives of Glynn County requested the EPA provide a public comment meeting for the LCP Chemicals Superfund site marsh proposed plan?

Does EPA feel it is appropriate to limit participation in decision-making process to those with access to the internet, email, or innate ability to write comments to participate in the decision-making process?

<u>1.3 Setting and Hydrodynamics of the Marsh</u>

> "The intertidal vegetated marshes are a net depositional zone for suspended sediments due to the low current velocities and presence of vegetation within those areas. "Net depositional" means that particles are more likely to settle than to scour from the area."

What data is presented in support of this statement? How much sediment has accumulated or eroded from the LCP Site?

If the LCP marsh has a net deposition of particles, what is the annual deposition rate?

> "The Turtle River water surface elevation can vary in excess of nine ft during a tidal cycle."

Are these tides consistent with an area with "low current velocities"?"

What are the tidal ranges for the St. Simons sound estuary under storm conditions such as a northeast wind?

How does the wind effect currents in the estuary and on the tidal flats?

<u>Figure 1, Figure 2</u>

Why is the Salt Dock area not shown as part of the LCP Site?

How were the LCP Site boundaries shown in Figure 2 determined?

With the boundaries of the LCP Chemicals Superfund site determined by land ownership or by the extent of the contamination?

Are Superfund sites boundaries supposed to be determined by the extent of contamination or the surveyed ownership lines?

Past Actions

> "The approximately 13 acres of highly contaminated marsh sediments were excavated, backfilled with clean fill, and re-vegetated with native marsh grasses."

Why is marsh removal and re-vegetation with native marsh grasses not part of the Proposed Plan?

Were coffer dams used during past actions?

If coffer dams were used in the past, why was this technology not considered in the Feasibility Study?

What was the decision-making matrix that leads the exclusion of all technologies deployed from the uplands or utilizing dry excavation techniques?

> "As a result of these removal actions, the remaining contamination in OU1 is considered to be low-level threat waste to be addressed by this Superfund remedial action."

Is there only "highly contaminated..." and "low level threat..." wastes at the site?

Who made the determination that the remaining wastes are "...low-level threat waste"?

What is the definition of low-level threat waste?

What is the difference between waste and COCs?

How does the EPA quantify low-level threat waste and what is the threat level to humans and wildlife?

What are the numerical difference between low level, mid-level, and high level wastes for the Chemicals of Concern (COC) at the LCP Chemicals Superfund site?

Where can the low, mid, and high levels of waste threats definitions be found in EPA rules and regulations?

Mr. Franklin Hill of the Superfund branch at EPA Region 4 has publicly stated in an Atlantic Journal-Constitution Op-Ed that there is only residual contamination at the LCP Chemicals Superfund site.

How does the EPA defined residual contamination and how is that numerically quantified?

Would contamination that has resulted in documented sick Dolphins within this estuary qualify under the definition of residual contamination?

2.0 SITE CHARACTERISTICS

> "As a result of the RI studies and risk assessments, a limited number of contaminants were identified as **contaminants of concern** (COCs) (emphasis added) that warranted further evaluation and remedial action under CERCLA."

Were the COCs that have synergistic and similar modes of action considered, or were COSs like dioxin/furan excluded, even if they should be considered along with PCBs?

Were all PCBs included or were the others excluded and only Aroclor 1268 included?

If so, why?

If not, why is the data missing?

2.1 Distribution of COCs in Sediment

> "Figures 3 through 6 show the COC concentrations in surface sediment samples, defined as samples with a starting depth at the sediment surface and collected from the interval of 0-to-6 inches, or 0-to-1 ft below the sediment surface; the 0-to-1 ft interval was used when upper 6-inch intervals were unavailable."

Fiddler Crabs mix sediment up to 36 inches below ground.

Why was sampling limited to 6 or 12 inches?

Was the EPA or the PRPs unaware of the biosphere depth in the estuary that inhabits the marsh sediments?

Did the US Fish and Wildlife Service (USFWS) advise the EPA that sampling to only 12 inches was insufficient to delineate contamination in the LCP Marsh (USFWS, 1996)?

Did the USFWS advise the EPA to conduct whole body fish analysis?

Has the EPA assured whole body fish analysis has been conducted?

Did the USFWS note the Spartina root bed extends to 18 inches and COCs at this depth might have a higher propensity to be bioavailable (USFWS, 1996)?

How would the greater bioavailability of COCs at a depth of 18 inches affect a cap remedy?

Did the USFWS recommend in 1996 the EPA total "dioxin" levels reported for the nature and extent of the contamination within the marsh?

> "Two reference locations were used during the various ecological studies. One (Troup Creek) was located about 4.3 miles from the marsh, on the eastern side of the Brunswick

Peninsula, and the other west of Sapelo Island, over 25 miles from the Brunswick area. The purpose of these reference locations is to collect data from areas presumed to have been uncontaminated with the LCP Chemicals Site, for the sake of comparison."

In light of the data collected since 2012, does the EPA agree the Reference Stations are likely, if not confirmed, to be within the radius of contamination deposition from the LCP Site (ATSDR, 2014b)?

If the EPA disagrees, what data does the EPA have to support continued use of the Reference Stations?

"Methylmercury (MeHg) was measured at over 150 sediment sampling locations throughout OU1. The MeHg in sediment ranged from below detection limits to 0.05 mg/kg, with a mean concentration of 0.005 mg/kg. Only a small fraction of the mercury in sediment was present as MeHg. Because MeHg readily bioaccumulates, it is more prevalent and toxic in biota tissue and toxic than elemental mercury."

Does the EPA agree that there is only one sample of methylmercury for approximately every 4.5 acres of the LCP Site march? (640 acres/ 150 samples)

Is the reason a small fraction of the mercury was methylmercury because it readily bioaccumulates? If not, why not?

Figure 4 – Aroclor 1268 Concentrations in LCP Marsh Sediments

Why is there a high level of Aroclor 1268 reported at the Salt Dock in Figure 4?

Does this indicate dioxin/furan could have been transported to this area since the EPA and Honeywell argue the PCBs and dioxin/furan are co-located?

"The distribution of COCs clearly points to the Eastern Creek, LCP Ditch and portions of Domain 3 Creek near the Site Uplands as major contaminant sources. In addition the Eastern Creek and LCP Ditch are more directly influenced by tidal action that can mobilize contaminants into Purvis Creek and beyond, much more so than contaminants in vegetated wetland marsh areas with very low tidal energy."

"The high levels of MeHg and PCBs (primarily Aroclor 1268) detected in fish fillets resulted in a fish consumption advisory for the Turtle River/Brunswick Estuary (TRBE) issued by the Georgia Department of Natural Resources from 1995 to the present."

Why were fish not tested around the LCP Site and in Turtle River like they were at Lake Onondoga (whole, filet, juvenal and adult) and include dioxin and furans (USEPA, 2002)?

What Is Risk and How Is it Calculated?

> "A Superfund BRA is an analysis of the potential adverse effects caused by hazardous substances at a site under current and future conditions in the absence of any actions to control or mitigate these effects."

If the BRA is an analysis of current and future conditions, why does it use data 20 years old (DHHS, 1999)?

Did the ATSDR Public Health Assessment discredit the study used to establish the annual number of seafood meals used to determine risk (ATSDR, 2014a)?

Exposure Assessment

> "The high quantity fish consumer scenario evaluated exposures to individuals who consume more locally-caught fish, assumed to be 40 meals per year, than the typical recreational anglers."

If the BRA is an analysis of current and future conditions, why is it using data 20 years old (DHHS, 1999)?

Did the ATSDR Public health Assessment discredit the use of DHHS, 1999 with the following statement?

> "And finally, it should be noted that African-Americans made up only 4% (9 out of 211) of the people who participated in the study. African-Americans make up 26% of the population of Glynn County and nearly 40% of the population within four miles of the LCP Chemicals Site. Therefore, African-Americans are underrepresented in the Brunswick fish study.
>
> A study of fishers along the Savannah River showed that African-Americans
> - Eat more fish meals per month than whites (average, 5.4 vs. 2.9),
> - Eat slightly larger portions than whites (average, 13.7 oz. vs. 13.1), and
> - Eat higher amounts of fish per month than whites (average, 75 ounces vs. 41 ounces).
>
> It is reasonable to assume that the fish-eating habits of African-Americans in Brunswick, Georgia, are similar to African-Americans along the Savannah River. Therefore, African Americans who fish along the Turtle River are likely to have higher exposure to mercury from eating fish than whites. The results of the Brunswick fish study should not be applied to African Americans in the Brunswick area for those reasons." (ATSDR, 2014a)

Did the Sapelo Study of Chemicals in seafood consumer find an annual consumption rate closer to 156 meals per year (ARSDR, 2014b)?

> "Because risk assessments are designed to be conservative to ensure that risk management strategies will be protective of human health, as well as consistent with EPA requirements, two types of exposure scenarios were analyzed in the Baseline HHRA to assess the range of potential risk: the reasonable maximum exposure (RME), which

estimates the highest level of human exposure that could be reasonably expected to occur, and the central tendency exposure (CTE or "typical") scenario. Cancer and non-cancer health hazards were assessed under both these scenarios."

Does the EPA now realize the Baseline HHRA is seriously flawed?

<u>Toxicity Assessment</u>

"The Baseline HHRA provided detailed discussions on the toxicity of mercury and PCBs (Aroclor 1268) and their associated uncertainties."

Why is the additive effect from dioxin and furan not included in the discussion of associated uncertainties (EPA, 2000)?

Does EPA guidance instruct to include dioxin and furan in the analysis of the carcinogenic and non-carcinogenic effects of PCBs like Aroclor 1268 and the other PCBs found at the LCP Site (EPA, 2000)?

"*Cancer risks:* Cancer risks are only associated with Aroclor-1268."

Was the dioxin and furans known to be present in seafood and sediment evaluated in included in the Toxicity Assessment?

Does the EPA acknowledge the above statement is incorrect and there are cancer risks associated with dioxin and furans found in the LCP Site area and in Turtle River (EPA, 1996)?

"*Non-cancer health hazards:* The calculated RME non-cancer HIs ranged from 0.7 for consumption of shellfish to 8 for the child high quantity fish consumer. Adult recreational anglers would have a HI of 3 and the adult high-quantity fish consumer would have a HI of 5, both of which exceed EPA's acceptable level. Calculated CTE hazards exceeding the acceptable level are for child consumption of fish and shellfish and the high quantity fish consumer. The calculated RME non-cancer HIs ranged from 1 for the adolescent to 5 for the child."

Were this levels of risk based upon the discredited 40 meals per year (DHHS, 1999; ATSDR, 2014a)?

"There were no unacceptable health hazards or risks associated with lead or PAHs. The only two contaminants that contribute to unacceptable human health risks are mercury and Aroclor 1268."

Was dioxin furan data available to the EPA utilized in the Toxicity Assessment and factored into this statement?

Does the existing dioxin/furan data exceed the EPA allowable levels in seafood (GA DNR, 1989; GADNR, 1990; GADNR 1991; GADNR, 1992; GADNR, 1993; GADNR, 1994)?

> "For example, Table 3 compares the current average edible tissue concentrations from the Baseline HHRA with the calculated protective tissue goals for the adult recreational fish/shellfish/clapper rail consumer at a HI of 1 and cancer risks at 1E-04 and 1E-06. These numbers and others from the Baseline HHRA and those calculated as part of the State of Georgia fish consumption advisory for the TRBE can be used for future monitoring to achieve edible tissue levels that will be protective of human health."

Is Table 3 based upon the discredited data (DHHS, 1999; ATSDR, 2014a)?

<u>4.2 Ecological Risks</u>

> "The COCs quantitatively evaluated in the BERA included mercury, Aroclor 1268, lead, and PAHs."

Was available dioxin and furans data included in the evaluation? If not, why not?

> "The results from tests on amphipods that burrow into the sediment indicated toxic effects in up to 85 percent of sediment samples from the LCP Chemicals marsh. However, toxicity was also observed in several reference samples from Troup Creek. Toxicity tests with grass shrimp (that generally float above the sediment) showed toxic effects in up to 69 percent of the samples, including those from reference stations. A detailed analysis of potential causes of the toxicity was presented in the BERA, along with the conclusion that, in addition to the COCs in sediment, various other non-measured factors likely influenced the tests, such as sulfide and organic carbon content, redox conditions, sediment pH, grain size, and potential pathogens in the test chambers."

In light of the toxicity sampling by the US National Park Service at Fort Puaski and Cumberland Island that did not find toxicity, does the sampling from the Reference Stations indicate they are toxic due to chemicals from the LCP Site, or failure of the lab to use appropriate protocols?

When questionable results are encountered, it is appropriate to repeat the test or do an analysis of the sediment to identify the toxic chemical or pathogen?

Did the EPA find any significance in the sediments being toxic to both burrowing and non-burrowing biota?

> "Table 4 summarizes the SEC concentrations based on the five statistical measures for the most sensitive toxicity tests (amphipod survival and grass shrimp embryo development). Although the data indicates a wide range of effect concentrations with low accuracies (**generally much less than a 50% chance of being correct** (emphasis added)), the SECs chosen were among the more reliable and accurate for these sensitive endpoints. Other test endpoints such as reproductive response and embryo hatching

resulted in higher SECs and even less accuracy. The SECs presented in Table 4 provide the basis for development of preliminary remedial goals."

Is it scientifically acceptable to the EPA to use data with a less than 50% chance of being correct to establish preliminary remedial goals?

Is the likelihood of the Proposed Plan working less than 50%?

If the data used has a likelihood of being less than 50% correct, how can a Proposed Plan based upon that data be any more correct or likelihood of success be anymore than "less than 50%"?

When questionable science is encountered, is the normal procedure to repeat the experiment to find the variables causing the low chance of being correct?

Is it correct to conclude the EPA saying the data being used has much less than a 50% chance of being correct?

"The LOAEL HQs suggest persistent low-level chronic effects."

What are the persistent low-level chronic effects expected to be present in the LCP Site marsh?

"None of the LOAEL HQs were exceeded for the redwing blackbird, marsh rabbit, raccoon and river otter, indicating minimal risks."

How many marsh rabbit, raccoon and river otter were sampled?

How many studies documented the population dynamics of marsh rabbit, raccoon and river at the LCP Site?

If none were conducted, why not?

Does the EPA have any empirical evidence or baseline monitoring to compare with the LOAEL HQs?

How does the EPA propose to evaluate the Remedial Action?

Has any data been collected to evaluate the upcoming Remedial Action or is all the data presented for the decision-making based upon models and assumptions?

If models and assumptions, when will baseline data (Baseline monitoring data) be collected for evaluating the remedy effectiveness?

Table 5. Summary of Risks to Wildlife Receptors

"Diamondback terrapin None < 1 < 1 None"

Please explain how the EPA can conclude a HI or HQ less than 1 when empirical data reported reproductive failure (EPA, 1997)?

Uncertainties Related to the BERA

> " The evaluation of potential adverse effects to the benthic invertebrate community relied on hundreds of site-specific acute and chronic toxicity test measurements using both indigenous and laboratory-cultured organisms. The OU1 BERA notes that the development of PRGs for the protection of benthic invertebrates is "**highly uncertain with poor accuracies**" (emphasis added) and that "only conservative assumptions were used" for this purpose;"

Why is data that is "highly uncertain with poor accuracies" being used in the proposed Plan?

When science is unreliable, is the appropriate action to repeat the data collection, analysis, or experiment?

Uncertainties Related to the Dioxin and Furans

Why does this section ignore and not report the large volume of dioxin and furan data available for this area of Turtle River (GA DNR, 1989; GADNR, 1990; GADNR 1991; GADNR, 1992; GADNR, 1993; GADNR, 1994)?

> "During the remedial design, areas outside the remediation footprint chosen will be sampled for dioxins/furans to ensure that any unacceptable risk is addressed."

Why does the EPA feel it is so important to avoid dioxin and furan sampling until after the Proposed Plan, Record of Decision, and the Consent Decree is entered into and approved by the court?

How will the EPA know what the "Remedial Footprint" is without the dioxin and furan data?

Would the dioxin and furan data be additive to the PCB risk assessment data for humans and wildlife?

How could this dioxin and furan data significantly change the Proposed Plan?

Could the unexpected toxicity observed be due to the very toxic dioxin and furan?

Could dioxin and furan be the variable that is accounting for the "...generally much less than a 50% chance of being correct..." noted in Section 4.2 Ecological Risks?

If not, what is the factor causing the large disparity?

As noted in the section of the LCP Site Proposed Plan, "Relationship between Dioxin/Furans and Chlor-alkali Sites":

> "At the Onondoga Lake Site, while dioxins/furans were determined to be both human health and ecological risk drivers as a result of fish consumption in Onondaga Lake,..."

Since this Onondaga Lake site is being used as a comparison site and as an argument to NOT test for dioxin and furan until after the Record of Decision and Consent Decree, why did the EPA NOT use the human health and ecological risk drivers found at Onondaga Lake in the LCP Site in Brunswick Risk Assessments?

Why did the EPA NOT do the same sampling at the LCP Site in Brunswick as at the Onondaga Lake Site?

Unlike Lake Onondaga, was dioxin and furan found widely distributed in the Turtle River and the St. Simons Sound estuarine system sediments (USEPA, 1995b)?

<u>Relationship between Dioxin/Furans and Chlor-alkali Sites</u>

The EPA's interjection of the Onondaga Lake LCP Site near Syracuse New York into the decision-making process for the LCP Site located in Brunswick Georgia presents an interesting situation. In order to compare and contrast the two sites the similarities and differences will need to be identified. In addition when similarities are found it will be interesting to note if the lessons learned have been applied to the LCP site in Brunswick Georgia.

> " The dioxins/furans and Aroclor 1268 sediment data collected to date show a strong relationship between dioxins/furans and Aroclor 1268 concentrations. A similar relationship was found at the Onondoga Lake and Ninemile Creek Superfund sites in upstate New York. **At the Onondoga Lake Site, while dioxins/furans were determined to be both human health and ecological risk drivers as a result of fish consumption in Onondaga Lake,** (emphasis added) they were not found to be widespread in lake sediments. The New York State Department of Environmental Conservation (NYSDEC) sediment screening criteria for protection of wildlife and humans from bioaccumulation were used as comparison values for the dioxins/furans. The areas where dioxins/furans are elevated are generally co-located with areas that exceeded the lake cleanup criteria for other contaminants, which are being addressed under the lake remedy.
>
> There was a similar situation with the Ninemile Creek Site and a similar approach was used. Dioxins/furans also contributed to Site risks but they exceeded the NYSDEC bioaccumulation screening criteria at only three of the 194 creek sample locations. These locations would be remediated based on concentrations of other detected contaminants (e.g., mercury).

Therefore, Site preliminary remediation goals for dioxins/furans in sediments were not developed."

At the Onondaga Lake site EPA found the dioxin and furans were a human health and ecological risk driver. But at the LCP site in Brunswick Georgia dioxin has not been considered as a risk driver in either the ecological or human health risk assessments.

Why has the EPA failed to apply the risk found at the LCP site in New York to the ecological and human health baseline risk assessments for the LCP site in Brunswick, Georgia?

Are the two Sites really similar and if so in what ways?

- **What are the similarities or differences in salinity ranges at the Lake Onondaga site when compared to the Brunswick Georgia site?**
- **What is the title range at the Lake Onondaga New York site compared to the Brunswick Georgia site?**
- **What is the rainfall at the Lake Onondaga New York site when compared to the Brunswick Georgia site?**
- **One of the water temperature ranges at the Lake Onondaga New York site when compared to the Brunswick Georgia site?**
- **What is the annual temperature ranges for the Lake Onondaga New York site when compared to the Brunswick Georgia site?**
- **Are the fish species found at Lake Onondaga New York site the same as those found at the Brunswick Georgia site?**
- **Does Lake Onondaga in New York have a Spartina marsh like at the LCP site in Brunswick Georgia?**
- **What is the water current speed in Ninemile Creek in New York and the current speed in Purvis Creek at the LCP site in Brunswick Georgia?**
- **Do people fish from Lake Onondaga in New York and from Turtle River near the LCP site in Brunswick Georgia?**

To my knowledge, the only similarity between the Lake Onondaga New York site in the Brunswick Georgia LCP site is that people consume fish from both the lake and Turtle River.

Does the EPA agree the only similarity between Lake Onondaga and Turtle River is people catch and eat fish from both locations?

Does the EPA agree the dioxin and furan is more widely distributed in the Turtle River area than at Lake Onondaga, and the EPA's data documents this dispersion (USEPA, 1995b)?

Will the EPA add the risks found from dioxin and furan in fish to the BERA and HHBRA for the LCP Site in Brunswick, Georgia? If not, why not?

As noted in the BERA:

In addition, Aleiandro et al., (2006) states that some of the Clapper Rail effects observed may be attributable to "organochlorides other than PCBs (e.g. dioxins)." Kannan et al., (1998a,b) also associate dioxin-like compounds to the Site. These papers suggest dioxins/furans may be associated with the Aroclors at LCP. The magnitude of the TEC dioxin concentrations particularly in Eastern Creek suggests collocated contamination with Aroclor 1268. In the absence of TEC-dioxin data in sediment elsewhere in the estuary or in biota samples, the potential contribution of TEC dioxins to existing risk is unknown.

Does the noted uncertainty, "...the potential contribution of TEC dioxins to existing risk is unknown", still exist?

Since the EPA has proposed a plan to remediate the LCP site in Brunswick Georgia without any dioxin furan data or any dioxin furan risk calculations for wildlife or people who consume the seafood, will the risk data from the Lake Onondaga site be used at the Brunswick Georgia site to better estimate the additive risk of dioxin and furan to the existing PCB contamination?

5.0 REMEDIAL ACTION OBJECTIVES (RAOS) AND PRELIMINARY REMEDIAL GOALS (PRGS)

The most conservative potential sediment PRG would be one which protects humans at an upper bound excess cancer risk of 1E-06, based on consumption of fish with Aroclor 1268. However, this would require a sediment clean up goal of 0.037 mg/kg, which would result in destruction of almost 700 acres of **otherwise functioning marsh** (emphasis added) and was therefore rejected as a potential goal.

What data does the EPA have to support the statement that the LCP Site is "...otherwise functioning marsh..."?

> "Similarly, if a 1E-05 cancer risk were used as the basis for establishing a sediment goal, the Aroclor 1268 concentration would need to be 0.37 mg/kg, which would result in unwarranted harm to approximately 586 acres or 77% of the entire marsh."

How large is the entire marsh in the Turtle River (St. Simons Sound)?

Would remediating to 1E-05 result in removing the entire marsh, or just the contaminated areas adjoining the LCP Site?

> "Early in the feasibility study process, EPA and GAEPD concluded that achievement of a mercury SWAC PRG of 1 mg/kg for the entire marsh would not be appropriate."
> And,
> " EPA and GAEPD reached this conclusion after thoroughly evaluating whether the removal or treatment of sediment contaminants in 33 of the 81 acres would cause more long-term ecological harm than no active remedial action, since such a large remedial foot print would cause widespread physical damage to habitat and species."

How did the EPA and GAEPD come to the conclusion that achievement of a mercury SWAC PRG of 1 mg/kg for the entire marsh would not be appropriate and what were the decision-making metrics?

What timeframe did the EPA and GAEPD consider long-term ecological harm?

How long will the mercury remain in the marsh and continue the methylation process?

How long will it take to remove the mercury contaminated marsh and complete the restoration process?

When comparing leaving the mercury in place and the continued methylation process or removing the mercury contaminated sediments and restoring the marsh, which alternative results in the shortest impact to the marsh and estuarine system when considered over the long-term?

6.0 DESCRIPTION OF ALTERNATIVES

The proposed plan section concerning the description of alternatives is more notable for what's missing than what is discussed. In 2000, a preliminary restoration scoping analysis was conducted for the LCP Chemicals Superfund site marsh (NOAA, 2000). During this analysis many more remedial technologies were examined them were mentioned in the feasibility study or brought forward in the Proposed Plan. The technologies considered include, but are not limited to, the following:

- Controlled placement of multilayers with or without geosynthetic fabrics
- Solidification or stabilization biomechanically mixing the upper layers of the sediments with stabilizing or solidifying agents, which typically uses cement bentonite or polymer-based materials. The discussion of this technology include the use of containment structures such as coffer dams and caissons.
- Bioremediation by stimulating indigenous microbial activity with nutrients are introduction of design microorganisms. This technology was not found applicable for Mercury and PCBs. Also, consistent mixing and Spartina marsh would've been difficult.
- Mechanical including clamshell buckets, backhoes, bucket ladder, or similar technology. The drawbacks identified where the need for construction of berms, walls and silk curtains, and proper installation would require an effort similar to a dry excavation. But it was noted the typical drawbacks to dredging including site access and adequate space for sediment handling are not in issue for the LCP site.
- Dry excavation with a berm damn or dike marsh areas, followed by draining excavation is sediments and backfill, moving the berms and replanting was identified as a technology suitable for the site. Furthermore the technology was identified as being more efficient, reduced loss of sediments, and complete removal of the contamination when compared with dredging techniques.

The failure of the proposed plan to evaluate technologies utilizing coffer dams, sheet piling, berms, or dikes is an oversight that brings in the question the completeness of the Proposed Plan. Notable is the number of similar structures within the area of the LCP site. These include the aeration basin at the adjoining pulp and paper mill, the dikes at the Andrews island dredge spoil area, and even the existing road out to Purvis Creek at the LCP site. Furthermore, it is evident that the authors of the Feasibility Study failed to see the usefulness of the existing roadway (LCP Site causeway) as a significant containment structure within the area needing remediation. Placement of a coffer dam or sheet piling would be a very doable technology for the LCP site. The area can be accessed from the uplands, the spoils brought to the uplands, and a single point of entry and exit established for the purpose of decontamination.

What was the rationale of the EPA in excluding technologies that utilized coffer dams sheet piling or similar technologies to confine the area, reduce sediment dispersion, and facilitate dewatering of the sediments needing removal?

Did the EPA compare technologies utilizing dredging versus coffer dams or sheet piling?

If the EPA did compare the technologies, why were technologies that left contamination in place or that have a high probability of recent spending sediments selected?

Did the EPA consider accessing the marsh via an upland route instead of by barge?

Was a barge used previously for the EPA Emergency Response and Removal or was the marsh accessed via the uplands?

<u>7.1 Overall Protection of Human Health and the Environment</u>

> "These reductions are likely to be observed only after several years post remediation (i.e., after a few generations of fish lifespans)."

How many years is "...after a few generations of fish lifespans"?

Which fish species are being used to determine "fish lifespans"?

<u>7.3 Long Term Effectiveness and Permanence</u>

> "Sediment removal, sediment capping, and to a lesser degree thin-cover placement have been found reliable and effective at sites similar to the LCP Chemicals marsh."

What example of a similar marsh or estuary with *Spartina alterniflora* is being referenced as the example? Do the "...sites similar to the LCP Chemicals marsh" have tides in excess of 9 feet, Fiddler crabs, and other burrowing birds and animals?

> "Materials for sediment capping and thin-cover placement will be sized to ensure protection against erosion and scour. However, the thin cover is not an armored contaminant barrier. Based on several case studies, some burrowing and other types of

biological activities will occur in the thin-cover layer, but are not expected to adversely impact its effectiveness in reducing exposures to the benthic community. Monitoring and maintenance will be performed as necessary to ensure long-term remedy effectiveness."

How will the cap reducing exposures to the benthic community with the 200 Fiddler Crabs per square meter, documented in the BERA, burrowing to a depth of 36 inches?

Will the cap be compromised by approximately 8% per year?

If not by approximately 8% per year, how much sediment will be brought to the surface each year by the 200 Fiddler Crabs per square meter?

What are the other burrowing animals that will further compromise the cap materials?

"Monitoring and maintenance will be performed as necessary to ensure long-term remedy effectiveness."

How often is the monitoring schedule to take place at the site and what will this entail?

How often will maintenance be performed and how will the areas be accessed?

Will funding be in place to conduct the monitoring and maintenance or will it be contingent upon approval and appropriations by the PRPs or in the case of the EPA, Congress?

How much money will be set aside for the monitoring and maintenance program?

Does the EPA the description of the monitoring and maintenance program in detail is critical to the success of the remediation?

If so, please do describe in detail and include in Responsiveness Summary and the Record of Decision.

"Where alternatives include sediment capping and thin-cover placement, long-term COC toxicity and mobility are reduced by creating a clean sediment surface through burial with clean materials."

How can the EPA claim "...long-term COC toxicity and mobility are reduced by creating a clean sediment surface through burial with clean materials", when the marsh is occupied by 200 Fiddler Crabs per square meter burrowing to a depth of 36 inches?

<u>7.4 Reduction of Toxicity, Mobility, or Volume (TMV) through Treatment</u>

"In Purvis Creek, In Purvis Creek, there is evidence that mercury fish and shellfish tissue concentrations have decreased over time.."

Does the EPA have whole fish sampling in support of the statement, "In Purvis Creek, there is evidence that mercury fish and shellfish tissue concentrations have decreased over time," or is this an opinion or based upon data that is not comparable or obtained by different sampling and analysis methods?

What is the source of the data of "evidence" the EPA is citing?

What are the two data sets being compared to conclude there is evidence of COC reduction in fish and shellfish to make this conclusion and where can they be found in the LCP Site documents?

Was the data collected used to conclude there is evidence of a reduction using EPA approved protocols?

Was both whole fish and filet sampling conducted?

> "The thin cover is not intended to function as an absolute contaminant barrier, but as a layer which will stimulate ongoing natural recovery processes. Therefore, some possible bioturbation beyond the cover depth is not expected to diminish the effectiveness of this remedy and would not preclude its beneficial use as a component of a protective remedy."

Where can the EPA's calculations for the bioturbation beyond the cover depth be found in the Feasibility Study?

Is the thin cover based upon data or what is expected?

Who is defining "what is expected" and what are their credentials to do so?

How much sediment is brought to the surface each year by 200 Fiddler Crabs per square meter?

What is the volume of sediment brought to the surface each year by the other burrowing animals in the marsh?

> "Capping and thin-cover placements, which leave contaminant material in place, isolate COCs and reduce bioavailability and mobility through burial with clean material."

How can the EPA claim "... isolate COCs and reduce bioavailability and mobility through burial with clean material.", when the marsh is occupied by 200 Fiddler Crabs per square meter burrowing to a depth of 36 inches?

What is the cap annual failure rate calculated by the EPA, and the associated reintroduction of COC to the biota?

"Residual risks posed by COCs left un-remediated are addressed through ICs (including permit requirements, which are already in place to limit use or future activities in the LCP Chemicals marsh and fish consumption advisories) and LTM."

A discussion of the EPA's history of implementing Institutional Controls is in the comments submitted on the HHBRA and incorporated herein by reference.

7.5 Short-term Effectiveness

> "These negative impacts primarily relate to extensive heavy equipment used for dredging and the transport of contaminated sediments through the community to an uplands disposal facility and clean material transport to the Site."

Was on-site treatment, the use of coffer dams of sheet pilling considered by the EPA or stakeholder agencies (USFWS, 1996)?

Were coffer dams used by the EPA during the removal action for the LCP Site dump during the Emergency Response and Removal Action?

Are coffer dams a proven technology at the LCP Site?

Did the EPA use coffer dams during the Emergency Response and Removal Action to keep sediments from entering the marsh and spreading further?

Did the EPA use coffer dams during the Emergency Response and Removal Action to control and contain tidal waters?

7.6 Implementability

8.0 PROPOSED CLEANUP LEVELS

> "The derivation of the ecologically-based CULs was also a complex process that involved consideration of the ecological relationship of the affected areas of remedy implementation to the surrounding habitat, the recovery potential of the affected ecological receptors, and the magnitude of current and predicted future effects of the COCs on local populations within the marsh."

Were ecological receptors such as dolphin, manatee, diamondback terrapin and mink considered in the derivation of the ecologically-based CULs? If not, why not?

Does the EPA realize the dolphin, manatee, and mink are either species very susceptible to the COCs from the LCP Site, protected species, or both susceptible and a protected species?

Was the EPA aware of the large amount of peer reviewed journal data concerning COCs in dolphins and people prior to the release of the Proposed Plan (ATSDR, 2014b)?

"Further, it was clear that not all discontinuous or isolated sediment locations that exceed PRGs could be removed without causing more harm than benefit."

Where can the "Harm/Benefit" analysis be found?

What was the timeline utilized to evaluate harm verses benefit?

Was short-term harm and restoration evaluated against the alternative of no action and long term risk to the ecosystem and human health?

What were the specific decision-making metrics used for the harm/benefit analysis?

What technologies were explored for these isolated high levels of COCs areas or areas that exceed remedial action goals?

"In accordance with the EPA's risk assessment guidance, the initial PRGs were based on the most conservative estimates, using the most sensitive sediment toxicity receptors and test endpoints. The range of mercury SECs was between 1.4 and 145 mg/kg. For Aroclor 1268, the SEC range was between 4 and 420 mg/kg. Similarly for PAHs and lead, the SEC concentrations ranged over an order of magnitude."

Did it occur to anyone in any of the stakeholder agencies that there is likely another COC causing the observed extreme range in toxicity?

"After evaluating each alternative that was presented in the FS, it was determined that the proposed CULs would still provide substantial protection to the benthic community without undue harm to the existing marsh, especially in combination with a robust monitoring program."

What does a "robust monitoring program" entail?

How often would the "robust monitoring program" be conducted?

Where are the sampling locations for the "robust monitoring program"?

When would the sampling and analysis start, and how long would the "robust monitoring program" be continued under the Record of Decision and Consent Decree?

Will dolphins, mink, and manatees be part of the "robust monitoring program"?

Has the EPA or the PRPs done the needed baseline monitoring over the past 20 years needed for a "robust monitoring program"?

If not, why should anyone believe the EPA or PRPs will start to do so now?

What does the EPA or PRPs have to show for work over the past 10 years to indicate they are competent to perform a "robust monitoring program"?

Has the EPA or PRPs collected the baseline data for a monitoring program? If not, why not?

Does a monitoring baseline need several data points to track changes, which requires several sampling events over time to establish the baseline?

> "Each of the SWAC and benthic community proposed CULs are expected to result in the attainment of the RAOs. In addition, surface water criteria that are identified as chemical-specific ARARs are expected, over time, to be attained as a result of dredging and capping of contaminated sediments."

What is the time period for attainment of the RAOs?

When will the effectiveness of the remedy be evaluated?

> "Where CULs may not be achieved and residual risks in some areas may occur, CERCLA and the NCP requires monitoring no less than every five years after implementation of the final remedy. Given that COCs will be left in place, a robust monitoring program, with triggers for additional actions, will be implemented as part of the selected remedy for OU1 to monitor and ensure success of the selected remedy."

What is the time period, specific goals, the decision-making metric by which the goals will be determined, and follow-up that will be implemented if goals are not reached?

Why are the goals not specified in the Proposed Plan?

Why are the goal decision-making metric by which the goals will be determined and triggers for additional action implementation, or the actions to be taken, not specified in the Proposed Plan?

Why is there no baseline monitoring to use in establishing goals to be reached?

Why has there been no baseline monitoring over the past 20 years?

Will the time period to reach the goals be specified in the Record of Decision?

What specific actions will be taken if the goals are not reached?

Has an analysis been conducted to compare the cost of conducting a remediation that will have a higher likelihood of success verses the cost of a "...robust monitoring program..." and the highly likely need to remobilize and conduct another remedial action due to minimal removal and significant unknown toxicity found during toxicity tests?

Will multiple remedial action shave a greater impact on the marsh than one comprehensive removal action and restoration?

9.0 SUMMARY OF THE PREFERRED ALTERNATIVE

A summary of preferred alternative cannot be conducted due the data deficiencies identified in the comments on the Baseline Ecological Risk Assessment and the Human Health Baseline Risk Assessment, and failure to evaluate all the technologies previously identified for inclusion in the Feasibility Study.

10.0 COMMUNITY PARTICIPATION

Please see comments concerning the Public Participation section of comments on the Proposed Plan for identified deficiencies and recommendations.

References

Armbruster, G., K.L. Gall, W.H. Gutenmann, and D.J. Lisk. 1989. Effects of trimming and cooking by several methods on polychlorinated biphenyls (PCBs) residues in bluefish. *J. Food Safety* 9:235-244.

ATSDR (Agency for Toxic Substances and Disease Registry). 1998c. *Toxicological Profile for Selected PCBs.* U.S. Department of Health and Human Services, Public Health Service, Atlanta, GA.

ATSDR (Agency for Toxic Substances and Disease Registry) 2008. Health Consultation, Arco Quarry Fish Tissue Sampling, Brunswick, Glynn County, Georgia

ATSDR (Agency for Toxic Substances and Disease Registry) 2014a. U.S. Department of Health and Human Services, Public Health Service, Division of Community Health Investigations.. "Public Health Assessment, LCP Chemicals Superfund site and Adjacent Areas." Brunswick, Georgia, EPA Facility ID: GAD099303182.

ATSDR (Agency for Toxic Substances and Disease Registry). 2014b. Polychlorinated Biphenyls (PCBs) in Georgia Coastal Environments and Populations. Lorraine C. Backer, L.C., Mellard, D.,

Balmer, B. C., L. H. Schwacke, R. S. Wells, R. C. George, et al. 2011. Relationship between persistent organic pollutants (POPs) and ranging patterns in common bottlenose dolphins (*Tursiops truncatus*) from coastal Georgia, USA. *Science of the Total Environment* 409: 2094-2101.

Balmer BC, Schwacke LH, Wells RS, Adams JD, et. al, (2013a). Comparison of abundance and habitat usage for common bottlenose dolphins between sites exposed to differential anthropogenic stressors within the estuaries of southern Georgia, U.S.A. Marine Mammal Science, 29(2): E114–E135 (April 2013) DOI: 10.1111/j.1748-7692.2012.00598.x

Balmer, B. C., Wells, R. S., Schwacke, L. H., Schwacke, J. H., Danielson, B., George, R. C., ... & Zolman, E. S. (2013b). Integrating multiple techniques to identify stock boundaries of common bottlenose dolphins (Tursiops truncatus).Aquatic Conservation: Marine and Freshwater Ecosystems.

Branson, D.R., T.I. Takahashi, W.M. Parker, and G.E. Blau. 1985. Bioconcentration kinetics of 2,3,7,8-tetrachlorodibenzo-p-dioxin in rainbow trout. *Environ. Toxicol. Chem.* 4:779-788.

Bruggeman, W.A., A. Opperhuizen, A. Wijbenga, and O. Hutzinger. 1984. Bioaccumulation of superlipophilic chemicals in fish. *Toxicol. Environ. Chem.* 7:173-189.

Bursian, S.J, et al. 2006. Dietary Exposure of Mink (*Mustela vision*) to Fish From the Housatonic River, Berkshire County, Massachusetts, USA: Effects on Organ Weights and Histology and hepatic concentrations of Polychlorinated Biphenyls and 2,3,7,8- Tettrachlorodibenzo-p-dioxin Toxic Equivalence. Environmental Toxicology and Chemistry, Vol. 25, No. 6, pp. 1541–1550, 2006

Bursian, S.J., et al. 2013. Dietary Exposure of Mink (*Mustela vison*) to Fish from the Upper Hudson River, New York, USA: Effects on Reproduction and offspring Growth and Mortality. Environmental Toxicology and Chemistry, Vol. 32, No. 4, pp. 780–793, 2013

Department of Health and Human Services (DHHS). (1999). Final Report: Consumption of Seafood and Wildgame Contaminated with Mercury, Brunswick, Glynn County, Georgia, July.

Gardner, A.M. and K.D. White. 1990. Polychlorinated dibenzofurans in the edible portion of selected fish. *Chemosphere* 21 (1-2): 215-222.

Georgia Department of Natural Resources. 1989. Results of Dioxin (TCCD) and Furan (TCDF) Analysis on Fish Tissue Composites From the Turtle River

Georgia Department of Natural Resources. 1990. Results of Dioxin (TCCD) and Furan (TCDF) Analysis on Fish Tissue Composites From the Turtle River

Georgia Department of Natural Resources. 1991. Results of Dioxin (TCCD) and Furan (TCDF) Analysis on Fish Tissue Composites From the Turtle River

Georgia Department of Natural Resources. 1992. Results of Dioxin (TCCD) and Furan (TCDF) Analysis on Fish Tissue Composites From the Turtle River

Georgia Department of Natural Resources. 1993. Results of Dioxin (TCCD) and Furan (TCDF) Analysis on Fish Tissue Composites From the Turtle River

Georgia Department of Natural Resources. 1994. Results of Dioxin (TCCD) and Furan (TCDF) Analysis on Fish Tissue Composites From the Turtle River

Gutenmann, W.H., J.G. Ebel Jr., H.T. Kuntz , K.S. Yourstone, and D.J. Lisk. l. 1992. Residues of p,p' DDE and mercury in lake trout as a function of age. *Arch. Environ. Contam. Toxicol.* 22:452-455.

Hart, L. B., Rotstein, D. S., Wells, R. S., Allen, J., Barleycorn, A., Balmer, B. C., & Schwacke, L. H. (2012). Skin Lesions on Common Bottlenose Dolphins (Tursiops truncatus) from Three Sites in the Northwest Atlantic, USA. PloS one, 7(3), e33081.

Honeywell. January 2015a. "Fact Sheet for the LCP Chemical Site."

Honeywell. February 2015b. "Fact Sheet for the LCP Chemical Site."

Hickie, B. E., Cadieux, M. A., Riehl, K. N., Bossart, G. D., Alava, J. J., & Fair, P. A. (2013). Modeling PCB-Bioaccumulation in the Bottlenose Dolphin (Tursiops truncatus): Estimating a Dietary Threshold Concentration. Environmental science & technology, 47(21), 12314-12324.

Kleeman, J., J.R. Olson, S.S. Chen, and R.E. Peterson. 1986a. Metabolism and disposition of 2,3,7,8-tetrachlorodibenzo-p-dioxin in rainbow trout. *Toxicol. Appl. Pharmacol.* 83:391-401.

Kleeman, J., J.R. Olson, S.S. Chen, and R.E. Peterson. 1986b. 2,3,7,8- tetrachlorodibenzo-p-dioxin metabolism and disposition in yellow perch. *Toxicol. Appl. Pharmacol.* 83:402-411.

Lake, J.L., R. McKinney, C.A. Lake, F.A. Osterman, and J. Heltshe. 1995. Comparison of patterns of polychlorinated biphenyl congeners in water, sediment, and indigenous organisms from New Bedford Harbor, Massachusetts. *Arch. Environ. Contamin. Toxicol.* 29 (2): 207-220.

Marinucci, A.C.; Bartha R.,1982. Biomagnification of Aroclor 1242 in Decomposing Spartina Litter. Appl Environ Microbiol. 1982 Sep; 44(3): 669–677

Metcalf, T.L. and C.D. Metcalf. 1997. The trophodynamics of PCBs, including mono- and non-ortho congeners, in the food web of North-Central Lake Ontario. *Sci. Total Environ.* 201: 245-272.

Mrozek, E.; Seneca, E.; Hobbs, L. 1982. Polychlorinated biphenyl uptake and translation by Spartina alterniflora loisel. Water, Air & Soil Pollution; Jan 1982, Vol. 17 Issue 1, p3

Muir, D.C.G., A.L. Yarechewski, A. Knoll, and G.R.B. Webster. 1986. Bioconcentration and disposition of 1,3,6,8-tetrachlorodibenzo-p-dioxin and octachlorodibenzo-p-dioxin by rainbow trout and fathead minnows. *Environ. Toxicol. Chem.* 5: 261-272.

Niimi, A.J., and B.G. Oliver. 1989. Distribution of polychlorinated biphenyl congeners and other halocarbons in whole fish and muscle among Lake Ontario salmonids. *Environ. Sci. Technol.* 23: 83-88.

NOAA Central Administrative Support Center, Preliminary Restoration Scoping Analysis, LCP Chemicals Superfund Site, Brunswick, Georgia. May 12, 2000

NOAA Fisheries. "Marine Mammal Protection Act (MMPA)" 2013. http://www.nmfs.noaa.gov/pr/laws/mmpa/.

NOAA Fisheries. "2013 Bottlenose Dolphin unusual Mortality Event in the Mid-Atlantic" http://www.nmfs.noaa.gov/pr/health/mmume/midatldolphins2013.html.

NOAA Fisheries. "Morbillivirus Infection in Dolphins, Porpoises, and Whales" 2013. http://www.nmfs.noaa.gov/pr/health/mmume/midatlantic2013/morbillivirus_factsheet2013.pdf.

NOAA Fisheries. "Coastal Bottlenose Dolphin Stocks" 2013. http://www.nmfs.noaa.gov/pr/health/mmume/midatlantic2013/bnd_stocks.jpg.

NOAA Fisheries Office of Protected Resources. "Bottlenose Dolphin (Tursiops truncatus)" 2013. http://www.nmfs.noaa.gov/pr/species/mammals/cetaceans/bottlenosedolphin.htm.

Oliver, B.G. and A.J. Niimi. 1988. Trophodynamic analysis of polychlorinated biphenyl congeners and other chlorinated hydrocarbons in the Lake Ontario Ecosystem. *Environ. Sci. Technol.* 22: 388-397.

Pulster, E. L., K. L. Smalling, and K. A. Maruya. 2005. Polychlorinated biphenyls and toxaphene in preferred prey fish of coastal southeastern U.S. bottlenose dolphins (*Tursiops truncatus*). *Environmental Toxicology and Chemistry* 24(12): 3128-3136.

Pulster, E. L. and K. A. Maruya. 2008. Geographic specificity of Aroclor 1268 in bottlenose dolphins (*Tursiops truncatus*) frequenting the Turtle/Brunswick River Estuary, Georgia (USA). *Science of the Total Environment* 393: 367-375.

Sanders, M. and B.L. Hayes. 1988. Distribution pattern and reduction of polychlorinated biphenyls (PCB) in bluefish *(Pomatomus saltatrix lineaus)* fillets through adipose tissue removal. *Bull. Environ. Contam. Toxicol.* 41: 670-677.

Skea, J.C., H.A. Simonin, E.J. Harris, S. Jackling, and J.J. Spagnoli. 1979. Reducing levels of mirex, arochlor 1254, and DDE by trimming and cooking Lake Ontario brown trout (*Salmo trutta L.*) and smallmouth bass (*Micropterus dolomieui lacepede*). *J Great Lakes Res.* 5(2):153-159.

Schwacke, Lori H., Eric S. Zolman, Brian C. Balmer, Sylvain De Guise, R. C. George, Jennifer Hoguet, Aleta A. Hohn, et al. 2012. Anaemia, hypothyroidism and immune suppression associated with polychlorinated biphenyl exposure in bottlenose dolphins (tursiops truncatus). Proceedings.Biological Sciences / the Royal Society 279 (1726): 48.

Schubauer, J. P., and C. S. Hopkinson. 1984. Above- and belowground emergent macrophyte production and turnover in a coastal marsh ecosystem, Georgia. Limnol. Oceanogr. 29:1052-1065.

U.S. EPA. 2000. Guidance for Assessing Chemical Contaminant Data for Use in Fish Advisories, Volume 2: Risk Assessment and Fish Consumption Limits. EPA-823-B-00-008. U.S. Environmental Protection Agency, Office of Water, Washington, DC. 383 pp.

U.S. EPA (Environmental Protection Agency). 1994a. *Estimating Exposure to Dioxin-Like Compounds* (External review draft). (3 volumes). EPA/600/6-88/005Ca, 005Cb, 005Cc. Office of Research and Development, Washington, DC. June.

U.S. EPA (Environmental Protection Agency). 1995a. *Guidance for Assessing Chemical Contamination Data for Use in Fish Advisories, Volume 1: Fish Sampling and Analysis.* Second Edition. EPA 823-R-95-007. Office of Science and Technology, Washington, DC. September.

U.S. EPA (Environmental Protection Agency). 1995b. Community Based Environmental Project, Brunswick Community Study 12/95. Dioxin/Furans Toxic Equivalency Values (TEQ) in River Sediments.

U.S. EPA (Environmental Protection Agency).1997. Ecological Assessment, Ecological Risk Evaluation of the Salt Marsh and Adjacent Areas at the LCP Superfund Site, Brunswick, Georgia

U.S. EPA (Environmental Protection Agency). 2006a. Identification of the manufacturing processes conducted at the site that could potentially form dioxins and furans.

U.S. EPA (Environmental Protection Agency). 1998a. ENFORCEMENT ACTION MEMORANDUM: Determination of an Imminent and Substantial Threat to Public Health and the Environment at the Riverside Boulevard Area. Emergency Response Branch . June 30, 2008. http://www.epa.gov/region05/cleanup/dowchemical/pdfs/dowchemical_aoc_20080715_attachment_c.pdf

U.S. EPA (Environmental Protection Agency). 2002, Lake Ononaga Remedial Investigation, Appendix G1 Tables G1-111 to G1-115

U.S EPA (Environmental Protection Agency). 2003 Non-Dioxin-Like PCBs: Effects and Consideration in Ecological Risk Assessment (NCEA-C-1340 ERASC-003) June 2003

U.S. EPA (Environmental Protection Agency). 2006a. Identification of the manufacturing processes conducted at the site that could potentially form dioxins and furans. http://yosemite.epa.gov/r10/cleanup.nsf/9f3c21896330b4898825687b007a0f33/25e3e8edb66bd9a688257142006a3860/$file/1225775.pdf

U.S. EPA (Environmental Protection Agency), Region 4. November 2014. Superfund Proposed Plan: LCP Chemicals Superfund Site Operable Unit 1.

U.S. EPA (Environmental Protection Agency). 2015. EJView. ACS Summary Report, LCP Chemicals . http://epamap14.epa.gov/ejmap/entry.html

USFWS (Fish and Wildlife Service), Review of the Draft Report on the Ecological Assessment: Ecological Risk Evaluation of the Salt Marsh and Adjacent Areas at the LCP Chemicals Superfund Site. November 21, 1996.

Weis J. S., P. Weis, 2003. Metal uptake, transport and release by wetland plants: implications for phytoremediation and restoration. Environment International 30 (2004) 685– 700.

Windham, L., J.S. Weis; P. Weis. 2001. Patterns and processes of mercury release from leaves of two dominant salt marsh macrophytes, Phragmites australis and Spartina alterniflora. Estuaries December 2001, Volume 24, Issue 6, pp 787-795.

GEC
ynn Environmental Coalition

P.O. Box 2443
Brunswick, GA 31521
912-466-0934
gec@glynnenvironmental.org

February 13, 2015

Mr. Galo Jackson, Ms. Shelby Johnston
Remedial Project Manager
South Superfund remedial Branch
U.S EPA Region 4
61 Forsyth Street, SW
Atlanta, GA 30303-8960

Mr. Jackson and Ms. Johnston,

The following comments and attachments are submitted as part of the Public Comment period for the LCP Chemicals Superfund Site (LCP Site)Proposed Plan for the marsh, Operable Unit One (1), located in Brunswick, Glynn County, Georgia.

Attached, please find:

- Health Consultation, ORGANIC CHEMICAL RESIDUE IN SCHOOLYARD SOILS, GOODYEAR AND BURROUGHS-MOLLETTE ELEMENTARY SCHOOLS AND RISLEY MIDDLE SCHOOL AND EDO-MILLER PARK/LANIER FIELDCITY OF BRUNSWICK, GLYNN COUNTY, GEORGIA, MARCH 22, 2005 (ATSDR, 2005)
- Wind Rose for Glynn County (GLYNCO, Wind Rose)
- Polychlorinated Biphenyls (PCBs) in Georgia Coastal Environments and Populations, September 3, 2014, by Lorraine C. Backer, PhD; David Mellard, PhD; Health Studies Branch, National Center for Environmental Health, Eastern Branch, Agency for Toxic Substances and Disease Registry (Backer, 2014)

The study cited in the ATSDR Health Consultation (March 22, 2005) is, "Determination of Toxaphene in Brunswick (GA) Public Access Area Soils by Immunoassay and Gas Chromatography, October 23, 2002" (Frohlick, Maruya, 2002), will be sent via postal mail for the LCP Site Administrative Record. The report cited by ATSDR also contains information about the specific species (congeners) of PCBs detected at the schools and playgrounds across the Brunswick Peninsula.

Comments and Questions

The quality of a Superfund Site cleanup or containment is contingent upon an understanding about how chemicals and other contaminates were released into the environment, and other environmental factors. The LCP Site air monitoring detected PCBs at the fence line. The sampling of soils at schools and playgrounds found a gradient of PCBs across the Brunswick Peninsula (ATSDR, 2005; (Frohlick, Maruya, 2002). PCB contaminated sediments with the congeners associated with the LCP Site were found in a wide radius in sediments and biota (Backer, 2014).

- **Did the EPA evaluate air transport and deposition of PCBs from the LCP Site as part of the LCP Marsh Remedial Investigation, Baseline Ecological Risk Assessment, or Human Health Baseline Risk Assessment?**
- **Does the EPA agree that the gradient of PCBs documented across the Brunswick Peninsula is a result of air releases from the LCP Site? If not, what is the mechanism for the formation of a PCB gradient of congeners associated with the LCP Site?**
- **Does the EPA agree that the gradient of PCBs found across the Brunswick Peninsula likely extends into the marsh?**
- **Does the EPA agree that the gradient of PCBs found across the Brunswick Peninsula likely extends into the marsh and likely the deposition is according to wind direction?**
- **Does the EPA agree that the gradient of PCBs found across the Brunswick Peninsula likely extends to Sapelo Island and is an explanation for how PCBs associated with the LCP Site crossed tidal nodes, rivers, and other natural hydrological boundaries? If not, what is the explanation for the PCBs crossing hydrological boundaries and barriers?**
- **Have PCBs been found past the Reference Stations at Troup Creek and Crescent River?**
- **Were dioxin and Furan Found at the Reference Stations? If so, could the source be the LCP Site?**
- **Could the source of observed toxicity at the Reference Stations be from the air transport of toxic compounds from the LCP Site? If not, why not? What additional efforts were made to identify the cause of toxicity at the Reference Stations?**
- **Did the EPA look at nearby toxicity sampling stations used by the United States National Park Service at Cumberland Island and Fort Pulaski? If not, why not?**

- **Will the EPA consider using the sampling stations used by the United States National Park Service at Cumberland Island and Fort Pulaski as the Reference Stations for the LCP Site?**
- **Did the EPA ever consider the Reference Stations were within the area where chemicals and other compounds were released from the LCP Site? If not, why not?**
- **If the EPA did evaluate air transport and deposition, what was the estimated volume of PCBs distributed via air transport?**
- **Did the EPA evaluate the extensive record of air releases recorded by the Georgia Environmental Protection Division and documented in the LCP Site Removal Administrative Record?**
- **Does the Georgia Environmental Protection Division a documented air releases in the LCP Site Removal Administrative Record discuss the high temperature of the gasses released? What was the composition of the gasses released?**
- **Can heavier than air chemicals like PCBs and Dioxin/Furan be air transported in a release of heated gasses?**
- **What is the EPAs explanation for the gradient of PCB congeners associated with the LCP site that extend out from the Site?**

Thank you for your attention to this comments and we will look forward to your response.

Sincerely,

Daniel Parshley

Daniel Parshley, Project Manager

ackson, Galo

'om: Jill Jennings-McElheney <micahsmission@aol.com>
ent: Monday, March 16, 2015 11:57 PM
): Jackson, Galo
:: Mccarthy, Gina
ubject: Comments on LCP CleanUp

ear Galo:

m submitting these comments based on a newspaper article I read in January 2015:

tp://america.aljazeera.com/articles/2015/1/12/georgia-pollutionlcpsuperfund.html

m a Georgia native and reside in the Northeast part of the state. After my family and neighbors became victims of posure from industrial waste that EPA egregiously and flagrantly misrepresented in HRS scoring in the 1990s, my 4 ar old son was diagnosed with leukemia in 1998.

TER botched HRS scoring as an accepted pattern, and the negotiating of lives by EPA notated with "low target pulations" justifying false scores to not trigger enforcement, my toxic residency in Athens, GA, and in other places like heville, NC/CTS are not cleaned up until victims come forth with their tragic stories. Then begins the behind closed ors remedial delays strategized and instigated by the perpetrators. The results are the same revictimizing of those ho were violated by the agencies and poisoned by the industries. I doubt any rights through environmental regulatory ive been afforded to victims of this nature in EPA Region IV.

this time, I would like to submit my support for the clean up plan proposed by the Glynn Environmental Coalition.

vould also like to submit that victims' rights no longer be denied to families who have suffered at the hands of EPA tched HRS scoring followed by behind the scenes manipulation to delay site clean up. This unprofessional and ethical treatment of victims should cease immediately, and victims be afforded the rights to be fully disclosed and otected from deep pockets. The perpetrators should not be allowed to revictimize those they have externalized their aste upon.

ere is a list of victims' rights from the Department of Justice which should immediately be modified for the families o have tested for PCBs on Sapelo connected to this tragic two decade old violation of their human and civil rights.

tp://www.justice.gov/usao/resources/crime-victims-rights-ombudsman/victims-rights-act

ank you.

ncerely,

I Jennings-McElheney
O. Box 275
interville, GA 30683
icahsmission@aol.com

BRUNSWICK-GOLDEN ISLES CHAMBER OF COMMERCE
1505 Richmond Street, Second Floor
Brunswick, Georgia 31520
Telephone (912) 265-0620
FAX: (912) 265-0629
www.brunswickgoldenisleschamber.com

March 10, 2015

To: Mr. Galo Jackson, EPA Project Manager, LCP Project

Subject: EPA Region IV Proposed Plan to Remediate LCP Chemicals Marsh in Brunswick, Georgia

The Brunswick-Golden Isles Chamber of Commerce appreciates the opportunity to submit comments regarding the proposed marsh remedy for the former LCP Chemicals site in Brunswick. The Chamber has been following the activities at this site since LCP's shutdown in the 1990's. We understand that it is a complex site that required extensive studies. However, we also believe that the site has now been thoroughly investigated.

We don't purport to comprehend the technical details of EPA's proposed plan, but we understand from the EPA public meeting and the Honeywell presentations to the Chamber's Board of Directors, the Brunswick City Commission and the Brunswick Rotary Club, that it is based on scientifically sound principals and will be environmentally protective. We support the approval and implementation of your recommended remedy as soon as possible. It is in the best interest of Glynn County and the City of Brunswick to advance the cleanup and to redevelop the site, safely and expeditiously.

Sincerely,

M. H. Woodside
President

ALEX ATWOOD
ʒESENTATIVE, DISTRICT 179
) MAIN STREET, SUITE 201
ИONS ISLAND, GEORGIA 31522
912-264-4211 (O)
ww.alexatwoodstaterep.com
lex.Atwood@house.ga.gov

HOUSE OF REPRESENTATIVES
COVERDELL LEGISLATIVE OFFICE BUILDING
ROOM 401
ATLANTA, GEORGIA 30334
404-656-0152
404-651-5562 (fax)

STANDING COMMITTEES
Judiciary – Non-Civil
Insurance
Public Safety and Homeland Security – Secretary
Juvenile Justice – Vice Chairman
Appropriations – Chairman Public Safety Sub Committe

January 20, 2015

Mr. Galo Jackson
US Environmental Protection Agency, Region 4
Superfund Remedial Branch
Waste Management Division
61 Forsyth Street, SW
Atlanta, GA 30303

Dear Mr. Jackson,

I write regarding the LCP Chemicals Superfund Site in the City of Brunswick, Georgia, and the Proposed Plan issued by the U.S. Environmental Protection Agency (US EPA) and the GA Environmental Protection Division (GA EPD) on December 4, 2014. Specifically, on behalf of my constituents in Georgia District 179, which includes the superfund site, I request that the period for submitting public comment be extended at least sixty (60) days.

Since 1996, the LCP Chemicals Superfund site has been on the National Priorities List, ranking among the highest priorities among sites of known releases of toxic and hazardous substances. The citizens within my district and interested parties need more time to review and assess the decades of collected data and the alternatives assessments that have informed the US EPA's Proposed Plan. This information was only just compiled and made available to the public on December 3, 2014. While I appreciate the initial extension of time for public review (to February 2, 2015), the review period is still not sufficient.

I respectfully request that the US EPA extend the public comment period by 60 more days for interested parties to have adequate time to respond with their written comments. This would create a new deadline for public comment of March 31, 2015. I would appreciate a prompt response to this request.

Sincerely,

J. Alexander Atwood

Representative Alex Atwood

cc: Jeff Cown, Chief - GA EPD Land Protection Branch

January 21, 2015

Mr. Galo Jackson
US Environmental Protection Agency, Region 4
Superfund Remedial Branch
Waste Management Division
61 Forsyth Street, SW
Atlanta, GA 30303

Good afternoon Mr. Jackson,

I'm writing on behalf of myself, my family, and our business, SouthEast Adventure Outfitters regarding the LCP Chemicals Superfund Site in the City of Brunswick, Georgia, and the Proposed Plan issued by the U.S. Environmental Protection Agency (US EPA) and the GA Environmental Protection Division (GA EPD) on December 4, 2014. Specifically, I'm requesting that the period for submitting public comment be extended at least sixty days.

Since 1996, this site has ranked as a high priority in terms of toxicity, and after so many years an increase in 60 days hopefully is not an unreasonable request. We'd really appreciate more time to review and assess the decades of collected data and the alternatives assessments that have informed the US EPA's Proposed Plan. I was raised in Coastal GA only miles from this site and am raising our two kids not too far away on St. Simons. For these and future generations we do appreciate your consideration.

Respectfully, please consider extending the public comment period by 60 more days for interested parties to have adequate time to respond with their written comments. This would create a new deadline for public comment of March 31, 2015.

Sincerely,

Michael Gowen
313 Mallory Street
St. Simons Island, GA 31522

Copy:

Jeff Cown, Chief - GA EPD Land Protection Branch

ıckson, Galo

ɔm: Carolyn Rader <CRader@atlantaregional.com>
ınt: Thursday, December 04, 2014 5:43 PM
ı: Jackson, Galo
ɔ: Carolyn Rader (chrader@bellsouth.net)
ıbject: Comments on the EPA proposal to clean up the Brunswick Superfund Site

ːar Mr. Galo,

/ill not be able to attend tonight's hearing in Brunswick but I would like to submit comments in lieu of attendance in rson. For many years I have been aware, through various organizations such as the Georgia Environmental Project led Dr. Olin Ivey, in uncovering this toxic mess, and I am shocked to learn that the harmful impacts of this illegal and ımoral dumping of toxic waste extends far beyond what was previously known or understood.

ıave not had time to perform my own research or delve into the details but I would like to look up the work of the ientists at the Marine Institute because I recall that several papers were published on the heavy metal contamination the salt marshes and estuaries around the Sapelo and the effects on oysters and other sea and marsh life. Their search on industrial and man-made pollution into the coastal water bodies led to the formation of the Marshlands otection Act and other important legislation protecting Georgia's coastal resources. I lived on Sapelo in the 60s and ırly 70s so I am also concerned as to what extent I or my siblings were exposed to these chemicals at an early age in ır development.

ıe Center for a Sustainable Coast is the premiere, scientifically backed environmental advocacy and policy organization r the Georgia Coast. I highly recommend that the comments you ceive from David Kyler, the Center's director, on EPA's proposal for the Superfund site clean-up are taken very ːriously and followed closely.

ıank you,

Exemption 6 Personal Privacy

ırolyn Henry Rader

ırolyn H. Rader, AICP
incipal Program Specialist
ʒing and Health Resources
ːnter for Community Services

) Courtland Street, NE
ːlanta, Georgia 30303-2538

| 404.463.3224
| 404.463.3264

ːlantaregional.com

ʒewiseconnection.com

ɔnnect with ARC

n Facebook »

felong Communities on Facebook »

Follow us on **Twitter** »

Jackson, Galo

From: Clay Montague <montague@ufl.edu>
Sent: Sunday, March 15, 2015 4:37 PM
To: Jackson, Galo
Cc: Satilla Riverkeeper; gec@glynnenvironmental.org
Subject: Questions Pertaining to the Proposed LCP Superfund Cleanup

08 March 2015

Mr. Galo Jackson, Project Manager
Environmental Protection Agency
61 Forsyth Street
Atlanta, GA 30303

Dear Mr. Jackson:

I have a number of questions listed below that pertain to the planned cleanup of the LCP Superfund Site in Brunswick, Georgia. I live on the nearby Satilla River estuary. I am an estuarine scientist and university professor, and I have substantial concerns about impacts of the LCP site on the people that live with the contamination. Moreover, it is apparent to me that contaminants from the LCP site can connect widely through hydrology, sediment transport, and fishery resources.

Earlier I shared the questions below with the Satilla Riverkeeper and the Glynn Environmental Coalition, two environmental groups with a history of involvement with the LCP site. However, I now understand that you are the correct "point person" for the EPA, so I'm submitting them directly to you during the ongoing public comment period scheduled to end on March 16th.

I have reviewed the following two documents pertaining to the EPA's plan to address contamination at the LCP Superfund site in Brunswick, Georgia:
1) U.S. ENVIRONMENTAL PROTECTION AGENCY SUPERFUND PROPOSED PLAN, LCP CHEMICALS SUPERFUND SITE. OPERABLE UNIT 1
2) BASELINE ECOLOGICAL RISK ASSESSMENT FOR THE ESTUARY AT THE LCP CHEMICAL SITE IN BRUNSWICK, GEORGIA

Listed below are eight sets of related questions from me. I hope you can help with the answers.

1) What assurances can be given that capping contaminated sediments in place (rather than removing them) can withstand storm intensities at least comparable to that required for coastal construction? Does storm preparedness for coastal construction require structures to withstand FEMA-determined flood levels, and 120 mph wind speed? What similar storm preparedness standards will be required for the capping project?
Even with capping, might a storm with upland flooding and 120 mph winds suspend contaminated sediments in the LCP-contaminated sediments and spread them over the upland landscape into residential neighborhoods and businesses? During a flooding storm, would contaminated sediments settle onto roadways, where they could be further spread on the tires of roadway traffic, and suspended as dust into the air? Will construction criteria for a contaminant cap include even stricter minimum storm standards (based on higher flood levels and more powerful winds) in order to address the public risk of contaminant exposure during and after a storm? If a storm penetrates the cap, would contaminants spread far and wide once a bolus of contaminated sediments is suspended in coastal waters? Could any and all of the contaminants be spread by a storm, including mercury, lead, Aroclor 1268, PCBs, PAHs, dangerous dioxins, and others? If not, which would not be spread by a storm?

2) What warning signs have been posted in the estuary and at boat ramps to keep people from consuming fish and shellfish in the vicinity of the LCP site, and to keep boaters and swimmers from coming into contact with contaminated sediments? Who is responsible for these signs?

3) Are contaminated crabs still entering the public food supply? Are the sets of floats that are sometimes visible in waters adjacent to the LCP site from commercial or residential crab traps?

4) Have the people most likely to have been contaminated by LCP-tainted seafood been tested? Have sufficient numbers of people been tested for LCP contaminants? Has testing included those who eat large amounts of fish and shellfish from St Andrew Sound, Jekyll Sound, Jointer Creek, Christmas Creek, and the Satilla River estuary? Does the spin of the Earth (Coriolis effect) tend to turn local river discharges southward, which over the decades could have put contaminated sediments suspended at the LCP site into these areas, and along the beaches of Cumberland Island and into Christmas Creek? How many people have consumed large quantities of fish and shellfish from those waters during the decades of contamination at the LCP site? Has an effort been made to warn those people and to suggest that they be tested?

5) How is it known that only 81 acres of the 670+ acres of marshland at the LCP site is in need of remediation?

6) Is it true that 33 of these target 81 acres were not chosen for remediation because of concern over temporary damage to restorable marshland? If these 33 acres were included despite the damage to the marsh that might result, how would the amount and time frame of damage to the marsh compare to the risk to people that remains from leaving LCP-contaminated sediments in those 33 acres? Has this comparison of risk been the subject of a scientific risk assessment?

7) Among the contaminants allowed to remain in sediments at the LCP site, are any mutagenic or teratogenic, as well as carcinogenic? If so, what will be the risk of mutations and birth defects from human exposure to LCP-contaminated sediments, water, or seafood collected from impacted waters?

8) After the selected remediation process, what lasting risks to human health will remain? Who will be responsible for these and what remedies or recourse will they have? How safe will the environment be?
Will children be safely able to swim and boat in Purvis Creek or in the nearby open waters of Gibson Creek and Turtle River? Will people be able to safely eat fish and shellfish caught in the vicinity? Will warning signs be needed, and if so, who will be responsible for the warnings?

Please feel free to share these questions among those at EPA who might be able to answer them. I look forward to your reply.

Yours sincerely,

Clay L. Montague

--

Clay L Montague, PhD
Associate Professor Emeritus (Systems Ecology, Coastal Ecology) Howard T. Odum Center for Wetlands Department of Environmental Engineering Sciences University of Florida, Gainesville

Mailing Address:

Exemption 6 Personal Privacy

Restoring and Protecting the Satilla, Educating her Citizens

Satilla
[VERKEEPER®

Galo Jackson
Environmental Protection Agency
61 Forsyth Street
Atlanta, GA 30303
PHONE: (404) 562-8937
Email: jackson.galo@epa.gov

March 9, 2105

Dear Mr. Jackson,

Please see the comments below from Satilla Riverkeeper regarding the LCP Chemicals Superfund site proposed cleanup plan.

1. Area of Contamination vs. Area Designated for Remediation

- EPA's chosen cleanup plan for the LCP Chemicals site is inadequate identifying only 24 acres of marsh to be remediated. This is a problem because 81 acres of the march is heavily contaminated and should be removed for the good of public and environmental health. If this cleanup plan proceeds as planned the responsible parties would leave behind 57 acres of contaminated marsh with high levels of mercury and polychlorinated biphenyls (PCBs). These leads us to numerous questions...

- How is it known that only 81 acres of the 670+ acres of marshland at the LCP site is in need of remediation?
- Is it true that 33 of these target 81 acres were not chosen for remediation because of concern over temporary damage to restorable marshland?
- If these 33 acres were included despite the damage to the marsh that might result, how would the amount and time frame of damage to the marsh compare to the risk to people that remains from leaving LCP-contaminated sediments in those 33 acres?
- Has this comparison of risk been the subject of a scientific risk assessment?

Recommendations: The EPA should reevaluate their original cleanup plan and add the additional 57 acres of contaminated marsh, originally left out of the proposal, for cleanup.

2. Sediment Removal vs. Capping

- Capping and thin-cover placement methods are not an acceptable means of cleaning up a heavily contaminated tidal salt marsh. Both of these methods cover up contaminated soils rather than removing them forever. How can the EPA claim that thin-cover placement or caps is well studied method for site cleanup when there are less than ten thin layer caps at contaminated sites in the United States and these are mostly in lakes or bays? The thin-layer capping examples in the plan include estuarine, river, and tidal flats, of which are all systems with different hydrologies and cannot be adequately compared with salt marsh ecosystems. With this information it is obvious that the proposed capping plans are not applicable to the LCP site and is, at best, a science experiment in the field. This plan also does not seem very logical as natural storm events like hurricanes and sea level rise will bring an increased risk that the contaminated sediments will once again be disturbed and the capping work will ultimately fail.

- Thin-cover placement or enhanced natural recovery is not a sustainable recovery method. This thin layer of sediment, six inches or less will not be adequate to contain any contaminants in the marsh bed. Storm surge, the bottom of a boat passing by, and benthic infaunal invertebrates will disturb the layer. *Spartina* can also accumulate these pollutants and will continue to release them into the food web.

- Because of the high toxicity levels of the contaminated area in question and the proposed thin covering layer offered by the engineered cap, this plan, would be at best, just experimental when one considers an 8 or 9 foot tide and a meandering intertidal creek that is always present and on the move.

- What assurances can be given that capping contaminated sediments in place (rather than removing them) can withstand storm intensities at least comparable to that required for coastal construction?
- Does storm preparedness for coastal construction require structures to withstand FEMA-determined flood levels, and 120 mph wind speed?
- What similar storm preparedness standards will be required for the capping project?
- Even with capping, might a storm with upland flooding and 120 mph winds suspend contaminated sediments in the LCP-contaminated sediments and spread them over the upland landscape into residential neighborhoods and businesses?
- During a flooding storm, would contaminated sediments settle onto roadways, where they could be further spread on the tires of roadway traffic, and suspended as dust into the air?
- Will construction criteria for a contaminant cap include even stricter minimum storm standards (based on higher flood levels and more powerful winds) in order to address the public risk of contaminant exposure during and after a storm?
- If a storm penetrates the cap, would contaminants spread far and wide once a bolus of contaminated sediments is suspended in coastal waters?
- Could any and all of the contaminants be spread by a storm, including mercury, lead, Aroclor 1268, PCBs, PAHs, dangerous dioxins, and others? If not, which would not be spread by a storm?
- Did the EPA consider containment of the contaminated areas with a coffer dam and complete removal as one of the remedies in the Feasibility Study? If not, why not? Would a coffer dam or other containment structure facilitate removal without reintroducing the contaminated sediments in to the estuary?)
- Did the EPA model reintroduction of contaminants into the marsh via benthic organisms and the Spartina life cycle? If not, why not?

Recommendations: Do not waste time and money on capping projects that don't remove the contaminants from the environment. Please consider sediment removal to keep these contaminants from further entering the food web over the next century.

3. Restoring Vegetative Communities after Cleanup

- The proposed cleanup plan proposed by the EPA will include the removal of native marsh vegetation, which is critical for the health of the ecosystem as well as the neighboring estuarine systems. The proposed cleanup plan relies heavily on the assumption that marsh vegetation will re-grow on its own within two years. While it is possible that vegetation will begin to regrow, it is unlikely that the marsh will be fully restored in just two growing seasons.

- Have marsh vegetative restoration efforts been conducted at the LCP Site? If so, were they successful and should be repeated?

Recommendations: The EPA should modify their proposed cleanup plan to include a re-planting program in order to speed up recovery of the ecosystem post-remediation. We recommend focusing on natives such as *Spartina*, which is native to the salt marshes of coastal Georgia. *Spartina* will attractive native wildlife which will help speed up the ecosystem recovery process.

4. Human Health Assessment

- The human health assessment in the proposed plan does not adequately account for the risks posed by the contaminants to humans around the estuary. The two most harmful chemicals are mercury and Arclor 1268. Defined in the plan are high quantity fish consumers, adults that eat 40 fish meals per year for 20 years, and a recreational fish consumer as someone who eats 26 meals per year for 30 years. The differences between the two consumer categories are too small. The EPA should make more realistic assumptions like the Sapelo Island Study presented to the EPA Remedial Project Managers and Stakeholder Agencies for the LCP Site on September 3, 2014, which suggests a more appropriate number if meals in between 100 and 150 per year.

- Will the EPA increase the high quantity fish consumer number to 150 meals per year to reflect the actual consumption level observed in coastal Georgia populations?

-The posted fish consumption signs and public information on this subject is not an adequate source of information to alert the fishing and our seafood consuming public living in the contaminated areas where people rely heavily on seafood for their sustenance.

- How many signs has the EPA posted in the 20 years since the serious threat to human health was identified?
- Where are the EPA posted signs located?
- What is the EPA budget to maintain the signs over the past 20 years, and for sign placement and maintenance required until seafood is safe to eat?

- Over four thousand people live within a one mile radius of the LCP Superfund site. Over 400 of these citizens are 6 years or under and over 800 of these are women of child bearing age. In considering the many components of this major problem to one of our important coastal cities, the EPA must revise their fish consumption estimates and be cognizant of the health of those citizens that have already become affected with these toxins. This will take a voluntary testing program to learn about the human cost from this timely exposure to highly toxic contaminants now lurking in our marshes, soil, creeks, rivers, and now our coastal ocean bottom.

- What warning signs have been posted in the estuary and at boat ramps to keep people from to keep boaters and swimmers from coming into contact with contaminated sediments?
- Who is responsible for these signs now and into the future?
- Are contaminated crabs still entering the public food supply?
- Are the sets of floats that are sometimes visible in waters adjacent to the LCP site from commercial or residential crab traps?
- Have the people most likely to have been contaminated by LCP-tainted seafood been tested? Have sufficient numbers of people been tested for LCP contaminants?
- Has testing included those who eat large amounts of fish and shellfish from St Andrew Sound, Jekyll Sound, Jointer Creek, Christmas Creek, and the Satilla River estuary?
- How many people have consumed large quantities of fish and shellfish from those waters during the decades of contamination at the LCP site?
- Has an effort been made to warn those people and to suggest that they be tested?
- Among the contaminants allowed to remain in sediments at the LCP site, are any mutagenic or teratogenic, as well as carcinogenic? If so, what will be the risk of mutations and birth defects from human exposure to LCP-contaminated sediments, water, or seafood collected from impacted waters?
- Did the EPA consider three congeners, PCBs 138, 153, and 180, were particularly higher in women with endometriosis? If not, why not?

Recommendations: The fish consumption numbers should be increased based on detailed surveys of local fishermen. In this area 40 fish meals a year is an underestimate. Some residents eat fish every day and depend on it for their survival. A more appropriate number would be 150 meals per year, and this number is obtained from people actually consuming seafood in coastal Georgia.

5. Ecological Risk Assessment

- One of the sites used to compare the levels of sediment chemicals at LCP is only four miles from the LCP site at Troup Creek and has shown to be contaminated with the same chemicals.

Recommendations: The EPA should use a cleaner site for comparison. Choose a proper control site that has low to no levels of these contaminants. The available data from the US National Park Service sampling and analysis at Cumberland Island and Fort Pulaski would fulfill this need. Unlike the LCP data, this data is not of questionable quality.

6. Contamination in the Satilla River

- The dangerous spread of the contamination beyond the salt marsh is obvious proof that the so called site boundaries established by the EPA are far from being trustworthy.

These site boundaries could never be reliable when they only include the local marsh, the peripheral soil and the local groundwater. Sapelo is far offshore and the Satilla River has also been demonstrated to be contaminated with PCB 206 (most abundant congener in Aroclor 1268; ≥ 5.0 ppb) produced and dumped by the LCP plant (Backer and Mellard 2014). We now know that the data on Aroclor 1268 which is considered to have come from the LCP plant is showing up in our dolphin population, *Tursiops truncatus*, the ocean bottom sediments and in the blood of residents 25 miles offshore in Sapelo Island.

- Does the spin of the Earth (Coriolis effect) tend to turn local river discharges southward, which over the decades could have put contaminated sediments suspended at the LCP site into these areas, and along the beaches of Cumberland Island and into Christmas Creek?

Recommendations: The site boundaries must be rewritten and extend to all areas where these LCP toxins can be sampled and demonstrated with assurance.

Other Questions for Consideration

- What lasting risks to human health will remain after remediation? Who will be responsible for these and what remedies or recourse will they have?
- How safe will the environment be?
- Will children be safely able to swim and boat in Purvis Creek or in the nearby open waters of Gibson Creek and Turtle River?
- Will people be able to safely eat fish and shellfish caught in the vicinity?
- Will warning signs be needed, and if so, who will be responsible for the warnings?

Documents used for preparation:
1) U.S. ENVIRONMENTAL PROTECTION AGENCY SUPERFUND PROPOSED PLAN, LCP CHEMICALS SUPERFUND SITE. OPERABLE UNIT 1
2) BASELINE ECOLOGICAL RISK ASSESSMENT FOR THE ESTUARY AT THE LCP
CHEMICAL SITE IN BRUNSWICK, GEORGIA
3) OSHA Resource conservation and recovery act. Management of PCB.
4) Fisherman of Sapelo Island David Goldman AP
5) 2010 US Census Bureau
6) Polychlorinated Biphenyls USEPA Hazardous Waste 2014
7) Glynn county Health Department Seafood Consumption
8) US Department of Health and Human Services Toxic substances 2012
9) US Environmental Protection Agency 2014 Superfund site
10) POLYCHLORINATED BIPHENYLS (PCBs) IN GEORGIA COASTAL ENVIRONMETS AND POPULATIONS (Backer and Mellard 2014)

We would like to thank you and the EPA for hosting an EPA Public Comment meeting back in December of 2014 at the Brunswick public library. Though this event was well attended, it was poorly planned and did not serve the people of the community informatively, simply due to venue size and the lack of good communication on the part of the EPA. The EPA released its Administrative Record only 26 hours before the public comment meeting took place. The people of Brunswick who have been directly impacted by the LCP Chemicals Superfund site for decades deserve the EPA's upmost effort with communication and the flow of information to the public. We request that the EPA grant the communities of Brunswick a proper EPA Public Comment meeting that is well advertised to potentially interested parties and nearby residents.

If there are any questions you may have about our comments, please contact us at 912-510-9500 or riverkeeper@satillariverkeeper.org

Sincerely,

E. Ashby Nix

Ashby Nix
Satilla Riverkeeper and Executive Director

Aquafine
CORPORATION

3 DARIEN HIGHWAY
JNSWICK, GEORGIA 31525

PROCESSING EQUIPMENT AND CHEMICALS

TELEPHONE: 912-265-2000
TELEFAX: 912-265-3000

To: U.S. Environmental Protection Agency

Superfund Proposed Plan

LCP Superfund Site

Pls. return

Gentlemen- in accordance with your public comment solicitation dated November 16, 2015 current deadline extended to March 16, 2015, I have reviewed your six alternative plans for remediation of the LCP superfund site and respectfully offer comments and another alternative (7).

WE strongly agree that your proposed alternative 6 is preferred choice for the excellent reasons recited in your superfund proposed plan dated November 2014 as it minimizes sediment removal ,sediment capping, and thin cover placement lost. The least transfer of contaminated soil and least importation of good soil is the best overall outcome for the environment. All efforts should be made to avoid transfer and internment of toxic contaminants to other sites even with good safeguards in place. This avoids any risk of transferring pollution to another site regardless of how well protected the new repository is.

email: iannicelli@aquafinecorp.com

To: U.S. Environmental Protection Agency

Alternate Proposal 7 (AZorb™)

The best of all worlds would be to separate the pollutants in the most secure form that advanced technology can offer. We wish to propose a new, efficient low cost method for accomplishing this objective.

During the past ten years our company, has devised, reduced to practice and published a new breakthrough in pollution control technology that(AZorb™) combines the following advantages.

1) Broad spectrum sorption of heavy metals, organic pollutants, sanitary waste, and noxous gases.

2) High capacity

3) Low cost

4) Produced by economic remediation of a world wide waste and trial (red mud)

5) Stable after sorption (TCLP results)

Our pollution control reagent is prepared by the simple step of sulfidizing red mud, the waste by product of the Bayer process for extracting alumina from bauxite. Because of its broad range of sorbtive properties, our reagent has been trade named AZorb™.

Testing by an independent environmental laboratory has shown that AZorb does not release any of its sulfidized red mud pollutants (TCLP tests). It has also been shown that AZorb is equal to or better than ion exchange resins and avoids the expense for resin regeneration. Regeneration of resin merely transfers sorbed contaminants to another facility! With reference to use of AZorb at the LCP site, one preferred application would be to berm the LCP Domain near South Purvis Creek and install a HiFlo type thickener and ancillary filter as shown in the attached flow sheet(to recover AZorb™).

Installation of a thickener using AZorb™ would eliminate the cost of sediment removal, capping, the LCP Domains, and need to transfer polluted soil to a secure land fill!

We can produce and supply AZorb at our cost, probably less than twenty five cents per pound FOB Brunswick, GA.

Joseph Iannicelli Ph.D.
M.I.T.

Attachments: 2012 Seattle paper, CEN Article, Resume, and WestTech thickener installation

Cc: Governor- Nathan Deal

State Representative- Earl Carter

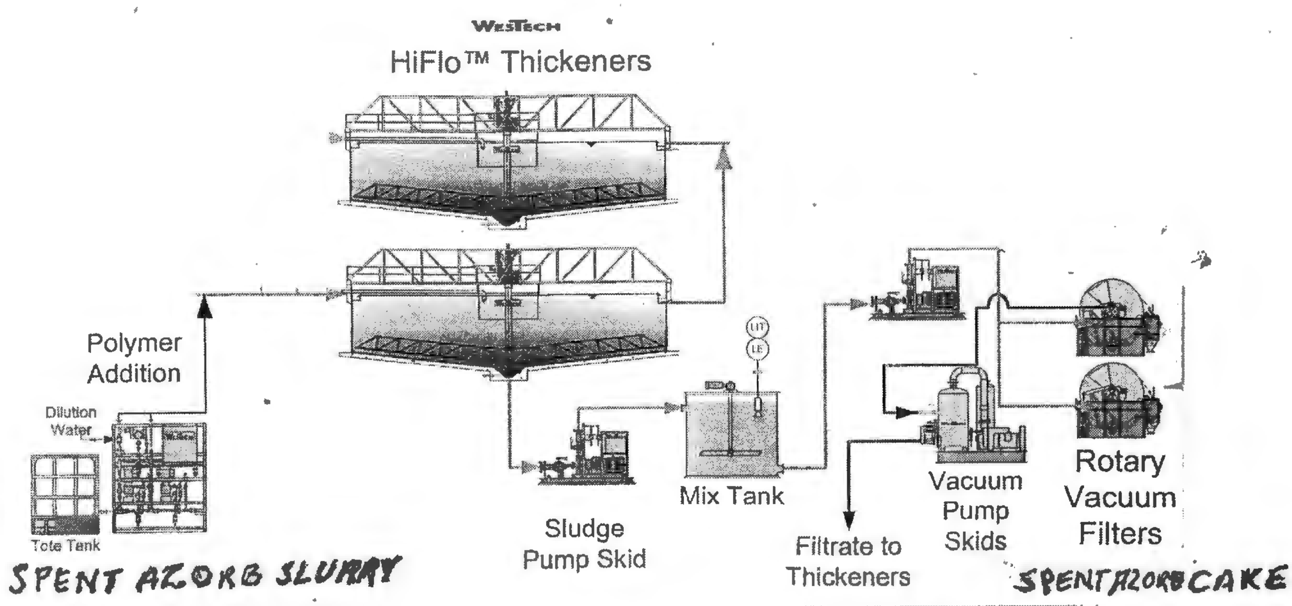
State Senator - William Ligon, Jr

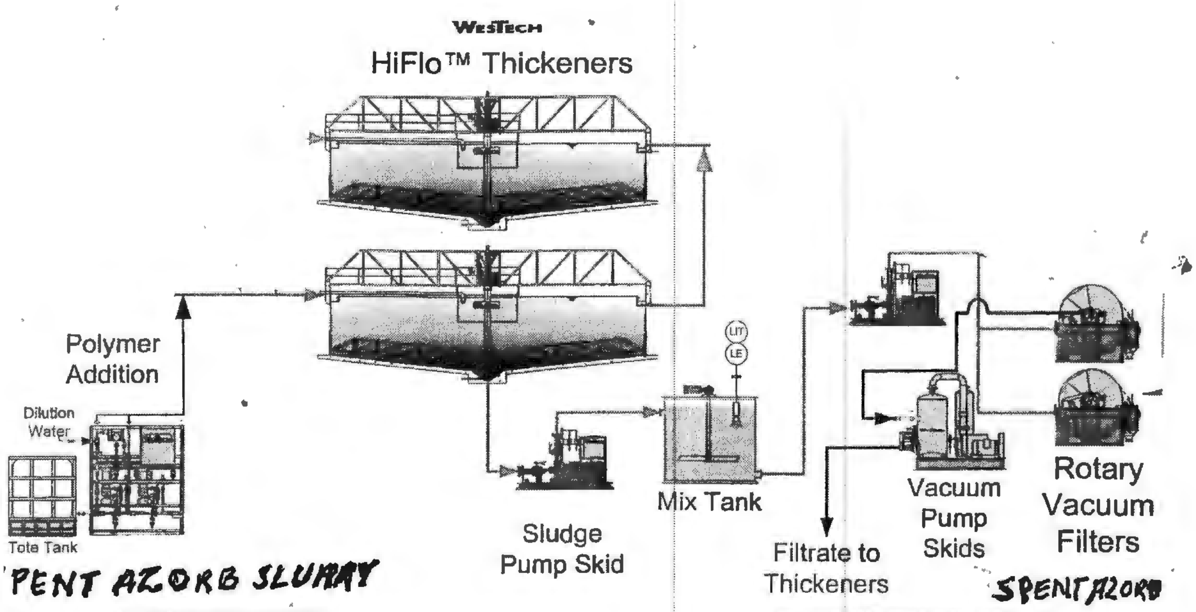
U.S. senator- Johnny Isakson

U.S. Senator- David Perdue

Mr. Milton Woodside- Glynn Chamber of Commerce

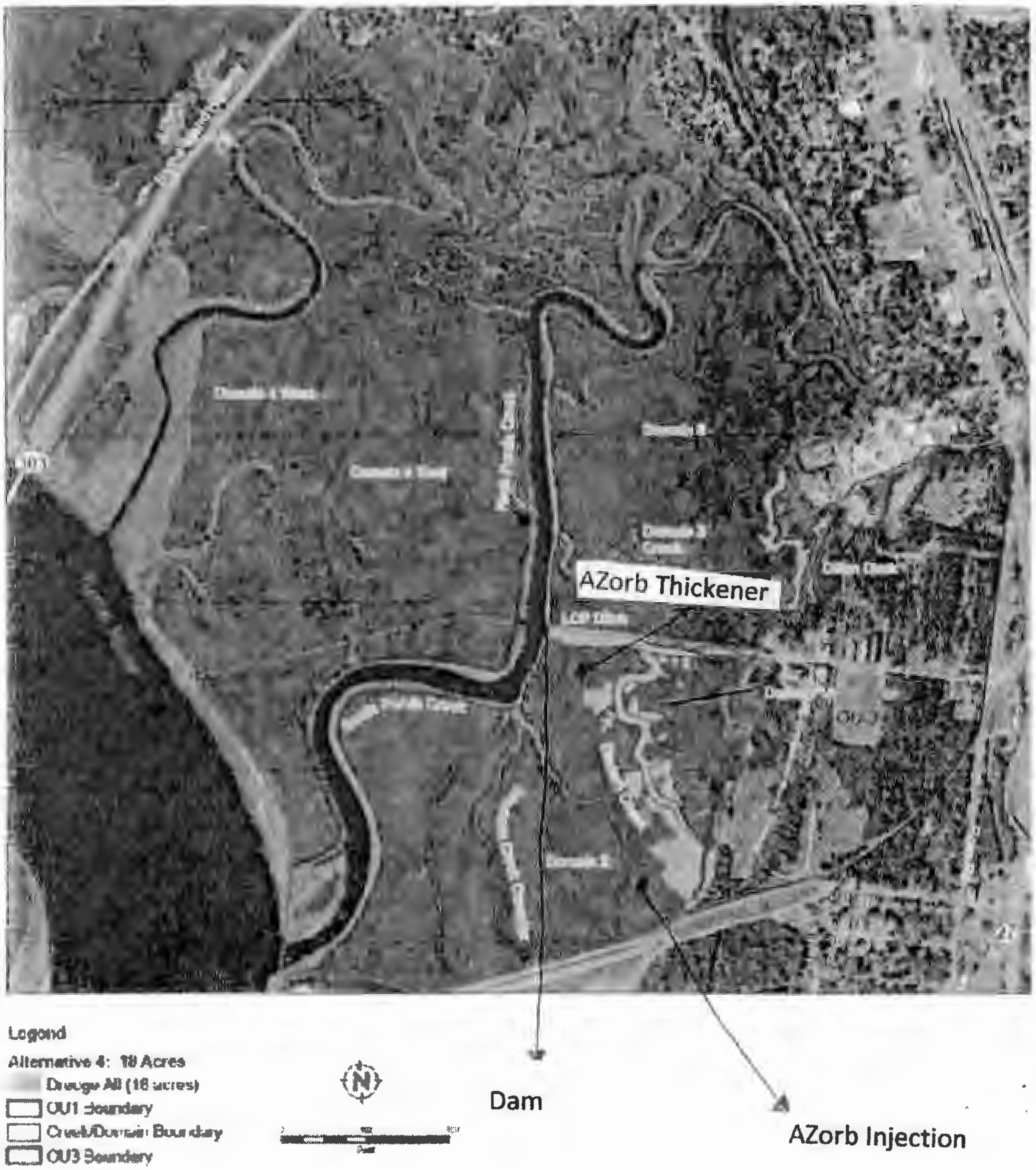
Bcc: Mr. Dan Parshley- Glynn Environmental Coalition


WesTech
HiFlo™ Thickeners
Polymer Addition
Dilution Water
Tote Tank
SPENT AZORB SLURRY
Sludge Pump Skid
Mix Tank
Filtrate to Thickeners
Vacuum Pump Skids
Rotary Vacuum Filters
SPENT AZORB CAKE



'PENT AZORB SLURRY
SPENT AZORB

Figure 9 – Sediment Remedy Alternative 4: Sediment Removal – 18 Acres



Exemption 6 Personal Privacy

IANNICELLI, JOSEPH

)UCATION

[redacted] S.B., Massachusetts Institute of Technology, Chemistry

[redacted] Ph.D., Massachusetts Institute of Technology, Organic Chemistry, minor in Patent Law.

(PERIENCE

87 – Present

Founder of Aero-Instant Spray Drying Services, Brunswick, Georgia, which conducts toll or custom spray drying of non-hazardous materials on ten Niro dryers. One of the leading custom spray drying firms in the U.S.

86 – Present

Co-founder with John Williamson and vice president of IMPEX (Industrial Minerals Process Equipment Corporation), a distributor of proprietary and major lines of wet process equipment used in mineral processing including: blungers, vibrating screens, clarifiers, filters, and calciners. Carry out test work and process development for domestic and international clients. Produce up to truckload quantities of processed industrial minerals from new deposits. Plan and design complete turnkey industrial minerals plants for U.S. and overseas clients. Projects include $16 million turnkey calciner for Thiele Kaolin and $18 million turnkey kaolin plant in Zhanjiang, China.

71 – Present

Founder and chief executive officer of Aquafine Corporation, 3963 Darien Highway, Brunswick, Georgia. Distributor and manufacturer's representative for major lines of wet processing equipment used in kaolin and industrial minerals industries. Founded and operated Culligan of Georgia, Inc.

71 – 1996

Exclusive world-wide representative for Pacific Electric Motor Company, Oakland, California. Product: magnetic separators. Sold thirty (30) large industrial magnetic separators (about 75% of total sold) and a number of smaller units to customers in the U.S., England, Germany, Finland, China, and Australia. Maintains the most complete high intensity magnetic separation laboratory and pilot plant in the U.S.

71 – 1996

Niro Atomizer, Inc., Columbia, Maryland, and Copenhagen, Denmark. Products: spray dryers, evaporators, fluid bed dryers. Represented Niro in Georgia, which has the highest concentration of large dryers in the world. Sold 95% of spray dryers acquired by kaolin firms in the U.S. Maintains laboratory, pilot plant, and small industrial dryers (Aero-Instant).

69 – 1971

Technical Director, Clay Division, J.M. Huber Corporation, Huber, Georgia. In charge of new process and product development in kaolin beneficiation and mineral modification. Head of a group of sixty-five (65) technical and non-technical personnel, which serviced a $20-million per year division (1970) having four plants in Georgia and South Carolina. Inventor of approximately one hundred (100) U.S. and foreign patents. Responsible for first commercial use of high gradient magnetic separation, now in use throughout the kaolin industry worldwide.

963 – 1968 Assistant Technical Director, Research Manager, and, previous to that, Research Supervisor, Clay Division, J.M. Huber Corporation, Huber, Georgia. Developed novel mineral beneficiation processes and equipment for high extraction magnetic separation, high shear leaching of iron minerals in clay, high-pressure comminution of clay slurries, selective anatase froth floatation, and fine media milling, spearheaded all phases of commercial development of surface modified specialty clays (Nulok, Nucap, Nupak, and Polyfil) from inception to pilot plant to commercial production and sales.

960 – 1963 Research Supervisor, Central Research Division, J.M. Huber Corporation, Borger, Texas. Supervised research on clays, synthetic silicates and on production of carbon black by catalytic pyrolysis of hydrocarbons, reinforcement of elastomers and plastics with various natural, synthetic, and modified pigments.

955 – 1960 Research Chemist, E.I. DuPont de Nemours & Company, Dacron Research Laboratory, Kinston, North Carolina. Headed special development projects at:

Pioneering Research Laboratory
Textile Fibers Department
Wilmington, Delaware 1958 – 1960

Carothers Research Laboratory (nylon)
Textile Fibers Department
Wilmington, Delaware 1957 – 1958

Technical Laboratory (dyes)
Organic Chemicals Department
Deepwater, New Jersey 1956

Member of the team that developed
T-62 and T-64 dyeable, anti-pilling Dacron

951 – 1955 Teaching Assistant, Massachusetts Institute of Technology, Cambridge, Massachusetts.

Summer projects in M.I.T. Metallurgy Department (corrosion of chromium/molybdenum/alloys) and at the Explosives Division of E.I. DuPont de Nemours & Company, Gibbstown, New Jersey.

WARDS

)12 Recipient SME-AIME Robert Earll McConnell Award for "Invention, development, and commercialization of high gradient magnetic separator".

annicelli, Joseph

\FFILIATIONS

Jew York Academy of Science
'echnical Association of the Pulp & Paper Industry
(Chairman, Pigments Committee 1970 – 1971)
\merican Institute of Mining, Metallurgical, and Petroleum Engineers
Member since 1974
Specialty Minerals Co-Chairman 1982
Surface Treated Minerals Chairman 1989
Robert Earll McConnell Award Committee 1993
Robert Earll McConnell Committee Chairman 1995 & 1996
merican Institute of Chemists (Fellow)
merican Chemical Society
'lay Minerals Society
1.I.T. Educational Council
merican Society for Testing and Materials
merican Ceramic Society
'anadian Pulp & Paper Industry
ilots International Association
merican Management Association

IOGRAPHIES

/ho's Who in America
/ho's Who in the World
merican Men of Science
/ho's Who in Science and Engineering
/ho's Who in Commerce and Industry
/ho's Who in the South and Southwest
ictionary of International Biography

IVIC ACTIVITIES

hairman, Glynn Union of Taxpayers 1995 – 1996
resident, Jekyll Island Citizens Association 1993 – 1995
resident, Georgia Tidewater Conservation Association 1991 – 1992
oreman, Glynn County Grand Jury 1989
lember, M.I.T. Educational Council 1963 – 1971
lember, Glynn County Board of Education 1998 – 2002, chairman 2002

annicelli, Joseph

atents

lagnetic Separation of Clays

,424,124	Method and Magnetic Separator for Removing Weakly Magnetic Particles from Slurries of Minute Mineral Particles
,471,011	Process for Improving the Brightness of Clays (U.S.)
,667,689	Method for Producing Mineral Products (U.S.)
423,983	Australian Patent
269,729	Austrian Patent
,122,523	British Patent
22,382	Chilean Patent
15,464	Columbian Patent
,490,027	French Patent
,571,552	German Patent
32,475	Greek Patent
106,550	Indian Patent
93,981	Mexican Patent
146,075	New Zealand Patent
46,253	Portuguese Patent
664,718	South African Patent
330,184	Spanish Patent
14,084	Turkish Patent
19,725	Venezuelan Patent

ligh Extraction Magnetic Separator

,347,396	British Patent
935,126	Canadian Patent
,111,986	German Patent
163,020	New Zealand Patent
55,388	Portuguese Patent
389,169	Spanish Patent

)ther U.S. Patents

,052,653	Metallic Phosphonate Containing Polyester
,068,207	Process for Increasing the Dyeability of Linear Condensation Polymer Esters with Chelatable Dyes
,193,344	Process for Bleaching Clay
,193,398	Mastic Compositions
,201,200	Modified Carbon Black Production
,203,765	Production of Carbon Black
,224,582	Kaolin Clay Beneficiation
,290,165	Surface Modified Pigments
,320,027	Clay Bleaching Under Non-Oxidizing Atmospheres

ınnicelli, Joseph

,323,932 Antioxidant Carbon Black
,335,020 Modified Carbon Blacks
,390,120 Polyurethanes Containing Amino Organosilane Modified Clay
,414,422 Chemically Treated Clays
,442,677 Chemically Treated Clays
,561,999 Metallic Stearate Coated Clays and the Process of Producing Same
,556,416 Apparatus for Shearing Solids in a Solids-Liquid Suspension
,567,680 Surface Modified Pigments and Methods for Producing Same and Elastomers Containing Same
,661,515 Method of Brightening Kaolin Clay by Removing Organic Contaminants
,667,688 Method for Shearing Solids in a Solids-Liquid Suspension
,667,689 Methods for Producing Mineral Products

atents Unassigned

,984,309 Magnetic Separator
,999,958 Coal Beneficiation

ssigned to Aquafine Corporation

,104,066 Canadian Patent, Thin-Section-Matrix Magnetic Separation Apparatus and Method
,215,821 Canadian Patent, Removing Total Reduced Sulfur Compounds from Industrial Gases
,216,732 Canadian Patent, Fluidization Process for Removing Total Reduced Sulfur Compounds from Industrial Gases
,576,158 UK Patent, Apparatus for Separating Particles from a Fluid-Particle Mixture
,149,389A UK Patent Application, Fluidization Process for Removing Total Reduced Sulfur Compounds from Industrial Gases
,149,389B UK Patent Application, Fluidization Process for Removing Total Reduced Sulfur Compounds from Industrial Gases
346,822B UK Patent, Continuous Filament Matrix for Magnetic Separator
,079,002 Thin-Section-Matrix Magnetic Separation Apparatus and Method
,552,734 Fluidization Process for Removing Total Reduced Sulfur Compounds from Industrial Gases
,552,735 Process for Removing Total Reduced Sulfur Compounds from Industrial Gases Using Manganese Dioxide
,713,225 Method for Removing Organic Reduced Sulfur Compounds
923,688 Wet Scrubber Process for Removing Total Reduced Sulfur Compounds from Industrial Gases
112,796 Manganese Dioxide Impregnated Filter
128,027 Method for Removing Mineral Slimes from Kaolin Clay
376,605 Process for Beneficiating Minnesota Kaolin
397,754 Method of Brightening Kaolin Clay by Thermal Oxidative Decarboxylation of Organic Contaminants
180,005 Continuous Filament Matrix for Magnetic Separator
224,777 Continuous Filament Matrix for Magnetic Separator
601,319B2 Process for the Manufacture of Monobasic Potassium Phosphate
686,401B1 Method for Sub-Glacial Mineral Reconnaissance and Recovery

ılfidized Red Mud Sorbent for Toxic Substances

annicelli, Joseph

',763,566B2 Method and Composition for Sorbing Toxic Substances
',807,058B2 Method and Composition for Sorbing Toxic Substances (CIP-1)
;,080,172B2 Method and Composition for Controlled Heat Release And Disposable Chemical Heater Utilizing Same
;,231,711B2 Sorption Processes - FGS
;,236,185B2 Methods for Using Sulfidized Red Mud – Sedimentation
;,377,310 B2 Method and Composition For Sorbing Toxic Substances – SRM + RM
;,382,991 B2 Method of Sorbing Discolored Organic Compounds from Water

'oreign Filings Pending

;ulfidized Red Mud - Europe, China, Canada

'ublications and Presentations

annicelli, J. "SRM – A New Sorbent for Toxic Substances" Paper Presented at the 2012 SME/AIME Annual Aeeting, Seattle, WA, February 19^{th} – 23^{rd}, 2012.

annicelli, J. "Evolution of High Gradient Magnetic Separation" Paper Presented at the 2010 SME/AIME Annual Meeting, Haydn Murray Symposium, February 28^{th} – March 3^{rd}, 2010.

annicelli, J. and J. Pechin, M. Ueyama, K. Ohkura, K. Hayashi, and K. Sato, A. Lauder and C. Rey, "Magnetic ;eparation of Kaolin Clay Using a High Temperature Superconducting Magnet System". Paper presented at the Applied Superconductivity Conference, August 29, 1996, Pittsburgh, PA.

annicelli, J., "High Tech Pigments by Novel Processing Methods". Paper presented at the AIME/SME Annual Meeting, February, 1990, Salt Lake City, UT.

annicelli, J., "Polymer Reinforcement with Amino and Mercaptosilane Grafted Kaolin". Paper presented at the AIME/SME Annual Meeting, February, 1990; Salt Lake City, UT.

annicelli, J., "The Iannicelli TRS Scrubber". Paper presented at the TAPPI Environmental Conference, April, 1986, New Orleans, LA.

Iannicelli, J., "New Trends in World-Wide Exploration of Kaolin Resources". International Clay Minerals Conference, 1985, Denver, CO.

Iannicelli, J., "Role of Kaolin Tailings Ponds in Conservation". Paper presented at the Society of Mining Engineers of AIME Fall Meeting, October 16-18, 1985, Albuquerque, NM; Preprint No. 85-395.

Iannicelli, J., "Kaolin Review 1985"; Engineering & Mining Journal 1986.

Iannicelli, J., "Beneficiation of Bauxite to Refractory Grade Quality by High Intensity Magnetic Separation"; AIME 1984.

Iannicelli, J., "Kaolin Review 1984"; Engineering & Mining Journal 1985.

Iannicelli, Joseph

Iannicelli, J., "Paramagnetic Separation in Ultrafine Industrial Minerals and Coal"; AIME 1983; pp. 105-115.

Iannicelli, J., "Kaolin Review 1983"; Engineering & Mining Journal 1984.

Iannicelli, J., "Cost Reduction Efforts Helped Industry Through Difficult Year in 1982"; Engineering & Mining Journal; March, 1983.

Iannicelli, J., "Advances in Large Spray Dryers". Paper presented at the Society of Mining Engineers of SME-AIME Annual Meeting, February 14-18, 1982, Dallas, TX; Preprint No. 82-38.

Iannicelli, J., "Evaluation of Comparison of Cross Field and Solenoid Field Magnetic Filters". Prepared for the Electric Power Research Institute, Inc., Research Project S106-1, 1981, Palo Alto, CA;.

annicelli, J., "Developments in the Kaolin Industry and Opportunities for Technology Transfer". Presented at he Niro Atomizer Kaolin Seminar, 1981, Hilton Head, SC.

annicelli, J., "Expansion and Soft Market Squeeze Profits in 1981"; Engineering & Mining Journal; March, 1981.

annicelli, J., "Production Plateaus in Unsettled Year of 1980"; Engineering & Mining Journal; March, 1981.

Murray, H.H. and J. Iannicelli, "High Intensity Magnetic Beneficiation of Industrial Minerals—A Survey". Study supported by The National Science Foundation (RANN); Project #GY 44129.

annicelli, J., "New Developments in the High Extraction Magnetic Filtration of Kaolin Clay". Paper presented at XIII International Mineral Processing Congress, June, 1979, Warsaw, Poland.

annicelli, J., "Record Year in 1979 Spurs Industry Expansion"; Engineering & Mining Journal; March, 1980.

annicelli, J., "High Intensity, High Gradient Magnetic Separation as a New Process Tool". Paper presented at he National Science Foundation Workshop, November, 1978, Columbia University, Sterling Forest, NY.

annicelli, J., "Kaolin—Record 1978 Output and Sales Promise a Bright Future"; Engineering & Mining Journal; March, 1979, pp. 121-122.

Malaka, N.J., J. Iannicelli, and J.A. Negrych, "Upgrading Ione Refractory Kaolins by High Extraction Magnetic/Filtration". Paper presented at the Society of Mining Engineers of AIME Fall Meeting and Exhibit, October 19-21, 1977, St. Louis, MO; Preprint No. 77-H-400.

annicelli, J., "High Intensity, High Gradient Magnetic Separation as a New Process Tool". Paper presented at he Joint Meeting of the American Institute of Chemical Engineers, Central Florida and Peninsular Florida Sections, May 20-22, 1977, Clearwater Beach, FL.

annicelli, J., "Kaolin; Production Reaches New High in '77"; Engineering & Mining Journal; March, 1978; pp. 188-192.

annicelli, Joseph

nnicelli, J., "New Developments in Magnetic Separation". IEEE Transactions on Magnetics, Vol. MAG-12, 'o. 5; September, 1976; pp. 436-443. Paper presented at the Magnetic Desulfurization Symposium, March 23-5, 1976, Auburn University, Auburn, AL.

nnicelli, J., "Development of High Extraction Magnetic Filtration by the Kaolin Industry of Georgia". IEEE ransactions on Magnetics, Vol. MAG-12, No. 5; September, 1976. Paper presented at the Magnetic esulfurization Symposium, March 23-25, 1976, Auburn University, Auburn, AL.

nnicelli, J., "High Extraction Magnetic Filtration Applications in Kaolin and Paper Making". Paper presented : the TAPPI Coating Conference, May 17-18, 1976, Boston, MA.

nnicelli, J., "Development of High Extraction Magnetic Filtration by the Kaolin Industry of Georgia". eorgia Geologic Survey, Information Circular No. 49, published Atlanta; 1978; pp. 44-52. Paper presented at ie Twelfth Forum on Geology of Industry of Industrial Minerals, April 22-24, 1976, Atlanta, GA.

nnicelli, J., "Kaolin—Modest Recovery, High Prices in 1976"; Engineering & Mining Journal; March, 1977; p. 139-140.

nnicelli, J., "High Extraction Magnetic Filtration of Kaolin Clay". Paper presented at the Society of Mining ngineers of AIME Annual Meeting, February 22-26, 1976, Las Vegas, NV; Preprint No. 76-H-7.

nnicelli, J., "High Extraction Magnetic Filtration of Kaolin Clay and Mineral Slimes". Filtration & eparation, January/February, 1976; pp. 15-18. Paper presented at the Magnetics Conference, April 14-17, 975, London, England.

nnicelli, J., "Extraction Magnetic Filtration of Kaolin Clay"; Clays and Clay Minerals, Vol. 24, Pergamon ress 1976; pp. 64-68. Paper presented at the International Clay Conference, July 16-23, 1975, Mexico City, lexico.

nnicelli, J., "Assessment of High Extraction Magnetic Filtration"; Document PB-240 880/5WW; National cience Foundation (RANN) ISRU, June 17, 1974, Washington, D.C. Available from the National Technical formation Service (NTIS).

nnicelli, J., "Grade Structure and Applications of Coating Clays". Presented at the Canadian Pulp and Paper ssociation Meeting, 1970, Montreal, Canada.

laynard, R.N., N. Millman, and J. Iannicelli, "A Method for Removing Titanium Dioxide Impurities from aolin". Clays and Clay Minerals, Vol. 17, Pergamon Press 1969; pp. 59-62.

nnicelli, J., "Factors Affecting Performance of Organo Clay Coating Agents in Fertilizers". Presented at the ertilizer Round Table, 1968, Washington, D.C.

bby, P.W., J. Iannicelli, and C.R. McGill, "Elastomer Reinforcement with Amino Silane Grafted Kaolin". esented at the Spring Meeting of the Division of Rubber Chemistry, American Chemical Society, Inc., 1967, lontreal, Canada.

ınnicelli, Joseph

ınnicelli, J., and N. Millman, "Relation of Viscosity of Kaolin—Water Suspensions of Montmorillonite ontent of Certain Georgia Clays". Presented at the XIV National Conference on Clays and Clay Minerals,)66, Berkeley, CA.

SULFIDIZED RED MUD
A NEW SORBENT FOR TOXIC SUBSTANCES

JOSEPH IANNICELLI, AQUAFINE CORP, BRUNSWICK, GA

ABSTRACT

A powerful improved sorbent is produced by sulfidizing red mud, a noxious by-product from the Bayer extraction of alumina from bauxite. Sulfidized red mud (SRM) sorbed 90 to 100% of the following metals from laboratory solutions of Cr, Co, Ni, Cu, Zn, Se, Ag, Cd, Hg, Pb, Th, U. Discolored organic compounds (DOC) are also sorbed (90%). Sulfidization of red mud is accomplished under ambient or relatively mild conditions using exemplary compounds such as H_2S, Na_2S, K_2S, $(NH_4)_2S$, and CaS_x. Sulfur content ranges from 0.2% to 10% above the residual sulfur in red mud. The sulfidization reaction blocks leaching of metals naturally present in red mud. In some cases, (As, Mn, Sr), mixtures of sulfidized red mud plus red mud are more effective than sulfidized red mud alone. Sulfidized red mud has applications for cleaning raw industrial process water as well as effluent wastewater (and gases) for the entire range of industrial processes.

BACKGROUND

Red mud is a noxious by-product and pollutant of the production of alumina from bauxite by the process invented by Karl Bayer in 1887. This process relies on the selective solubility of aluminous minerals in hot (125 - 250°C) sodium hydroxide solution and the insolubility of the remaining minerals (iron, titanium, and silica) which are either insoluble or react and re-precipitate. The insoluble, iron rich residue can contain 17.4 to 37.5% (Fe). Red mud is a complex mixture of finely divided hydrated iron oxides and a wide range of lesser minerals containing Al, Na, Ti, Si, Ca, Mg plus traces of over a score of other elements including Cr, Ni, Cu, Pb, Se, Hg, As, Th, etc.

The resulting red mud has strong sorptive and complexing properties and is the subject of scores of publications. Because of its preparation, red mud is intensely alkaline, with pH values of 13 and above, but also may contain and leach toxic metals. This creates serious problems with its storage in tailings impounds which poses a toxic hazard for wildlife and personnel, and creates widespread contamination of ground water. Reduction of pH below 10 is necessary for safe storage and many sorptive applications.

It is estimated that 150 million tonnes of red mud is produced and impounded per year and that about 2.5 billion tonnes is currently stored worldwide.

Hazards of storing highly caustic and toxic red mud has been brought into focus by the bursting of a red mud impound at Ajka, Hungary on October 4th, 2010 which released 700,000 tonnes of red mud over 40 square kilometers, killing ten people and hospitalizing 120 others. Neutralization of red mud can be accomplished with waste acid, or by washing red mud with large amounts of sea water (typically 12 to 18 times the volume of red mud). This requires seaside location, large settling basins, and of course the ability to discharge waste water back to the sea.

Red mud has been proposed as a sorbent for heavy metals, cyanides, phosphates, and the like. However, the sorptive and release properties of red mud are not always compatible.

Depending on the source of a particular red mud, it can leach out significant amounts of toxic pollutants such as radioactive thorium, uranium, chromium, barium, arsenic, copper, zinc, cobalt, as well as lead, cadmium, beryllium, and fluorides.

Red mud is a very hydrophilic high pH slime which is difficult to dewater by filtration or sedimentation means. This also complicates and limits its utility as a sorbent in aqueous systems.

The potential problems involved with use of red mud to control pollution are highlighted in an e-newsletter article entitled "The Great Red Mud Experiment that Went Radioactive". This experiment conducted by the Western Australian Agricultural Department involved placing 20 tonnes of Alcoa red mud per hectare on pastureland in order to stop unwanted phosphorous from entering waterways. An unintended result of this experiment was that runoff waters showed excessive quantities of copper, lead, mercury, arsenic, and selenium. Emaciated cattle grazing on treated land exhibited high chromium, cadmium, and fluoride levels. Furthermore, each hectare contained up to 30 kilograms of radioactive thorium. The disastrous red mud application test was abruptly terminated after five years.

It is evident that extreme caution must be exercised in selecting, treating, and testing red mud before attempting to use it to sorb toxic compounds.

Furthermore, the capacity of red mud to capture and hold toxic substances such as mercury and related metals often is not adequate to eliminate traces of these metals in leachate. The possibility also exists that sorption of one toxic pollutant may release other pollutants. Therefore, use of red mud as a sorbent to purify water is problematic.

As a result of intensive investigations on methods for neutralizing and using red mud, an Australian based company, Virotec, has developed a line of red mud based products covering a wide range of pollution control applications. Virotec uses a variety of methods to neutralize red mud. These involve use of natural sea water (up to 13 washings), evaporatively concentrated sea water, saline or hard groundwater brines, salt lake brines, industrial waste brines and even solid salts.

APPLICATIONS FOR SULFIDIZED RED MUD

Heavy metal contaminated liquids and flue gases from various sources (ground, stream, runoff, mines, petroleum, industrial waste) are among the most dangerous and difficult environmental problems facing the world today. Among these metals are mercury, chromium, cobalt, nickel, copper, zinc, silver, gold, cadmium, lead, selenium, and transuranic elements. Mercury contamination of the environment is the subject of increasing attention because it eventually accumulates at high levels in bodies of large predatory fish such as tuna, swordfish, and shark. A major concern is the atmospheric release of mercury from coal fired power plants, currently estimated at 46 tons per year in the United States. The Environmental Protection Agency (EPA) has identified women of childbearing age as especially threatened because of possible neurological damage to unborn children. It is estimated that 8% of women in this category have a methyl mercury blood level above 5.8 ppb.

On Dec. 14, 2000, the EPA issued a determination that their agency must propose new regulations under the Clean Air Act to control mercury emissions from coal and oil fired power plants by Dec. 15, 2003. One proposal was to reduce mercury emissions from power plants 90% by 2007. According to an article in Forbes, such regulation "could cost the power industry at least 8.58 billion dollars per year." More recent proposals such as the Clear Skies Act call for a 70% reduction in mercury emissions over 15 years. New deadline is 2016.

Sulfidized red mud is a powerful sorbent for remediating polluted sources such as groundwater, wastewater, mine runoff, petroleum streams, and industrial waste. Of particular interest is sorbing heavy metals such as mercury (Hg), chromium (Cr), lead (Pb), copper (Cu), zinc (Zn), silver (Ag), cadmium (Cd), selenium (Se), thorium (Th), and uranium (U) from such sources. The metals may be present as free elements, ions, or in compounds with other elements.

Of special interest is remediation of over 30,000 mine drainage streams where the alkalinity of sulfidized red mud would be useful.

PREPARATION OF SULFIDIZED RED MUD

The sorbent is prepared by the sulfidation of red mud, which contains hydrated ferro ferric oxides derived from the Bayer processing of bauxite ores. Sulfidation can be achieved by reacting red mud with one or more sulfidizing compounds such as H_2S, Na_2S, K_2S, $(NH_4)_2S$, and CaS_x. Unlike red mud, which is very hydrophilic, sulfidized red mud is lyophobic. As a result, sulfidized red mud has much faster dewatering rates than red mud.

The relative amount of sulfidizing agent is selected so that the sulfur content of the reaction product is from about 0.2 to about 10% above the residual sulfur content of the red mud. The weight ratio of sulfidizing compound to red mud will vary with the type of sulfidizing compound used and the desired level of sulfidation for a particular end use. Most often, the sulfidizing compound and red mud are combined at a weight ratio usually from about 1:25 to about 1:6. Conditions under which red mud can be sulfidized depend on such factors as the type of sulfidizing compound(s) and the intended use of the resulting sorbent. In some cases, sulfidation can be accomplished by mixing red mud and the sulfidizing compound at ambient temperature and atmospheric pressure. In general, higher sulfur contents can be obtained when the reaction is carried out at slightly elevated temperatures and/or elevated pressures. Sulfur content in the reaction product is affected by sulfur content of the sulfidizing agent. For example, compounds such as calcium polysulfide, usually yield products having higher sulfur contents.

When using gaseous sulfidizing compounds, such as hydrogen sulfide (H_2S), it is often preferred to conduct the reaction at slightly elevated temperature and/or elevated pressure to increase the rate of reaction and the sulfur content of the resulting sorbent. Suitable reaction temperatures range from about 40 to 200°C., often from about 80 to 120°C. The reaction pressure typically ranges from about 30 to about 70 psi (absolute).

USE OF SULFIDIZED RED MUD

In a typical application, the sorbent is slurried with a medium containing the contaminant(s) to be extracted. The sorbent, which forms a complex with the contaminant(s), can then be separated from the slurry using one or more conventional techniques such as filtration, sedimentation, or centrifugation.

In an alternative application, sulfidized red mud sorbent is processed into pellets using conventional pelletizing or extrusion equipment. The pellets can be used in filters of conventional construction in a variety of industrial or consumer filtration applications, including filters for preparing potable water.

It has been found that sulfidized red mud sorbent is effective for sorbing various contaminants, such as mercury, which are not effectively sorbed by red mud. On the other hand, red mud itself is effective for sorbing other contaminants, such as arsenic, which are not efficiently sorbed by sulfidized red mud. For treatment of media having contaminants in both categories, use of red mud and sulfidized red mud in tandem, either in the same sorbent composition or in sequential treatment stages (e.g., red mud followed by sulfidized red mud) can be more advantageous than using either sorbent alone.

RM 1. Preparation of Red Mud. A 1kg sample of red mud received from Sherwin Alumina Company of Corpus Christi, TX was slurried at 15% solids in demineralized water and filtered on a Buchner funnel. The resulting filter cake was re-slurried with demineralized water, re-filtered, and used as the starting material in Example 2.

SRM 2. Preparation of Sulfidized Red Mud Using Hydrogen Sulfide (H_2S). Washed red mud (100g) from Example 1 was slurried in demineralized water at 15% solids and the stirred slurry was saturated with hydrogen sulfide for 30 minutes at ambient temperature. The sample was dried overnight at 100°C. and the resulting cake was pulverized.

SRM 3. Preparation of Sulfidized Red Mud Using H_2S Under Pressure in a Parr Bomb. The sulfidation procedure of Example 2 was repeated using a Laboratory Parr Bomb. After saturation of the slurry with hydrogen sulfide gas, the bomb was sealed and heated four hours at 100°C., while stirred. The bomb was then cooled, depressurized and the contents filtered, dried, and pulverized.

SRM 4. Preparation of Sulfidized Red Mud Using Ammonium Sulfide $(NH_4)_2S$. Red
5% mud (200g) was dispersed in 600 grams of deionized (DI) water in a Waring Blender for 5 minutes. Ammonium sulfide (10g) was added and the slurry was heated with stirring on a hot plate for 1 hour at 60°C. It was then filtered and dried at 90°C.

SRM 5. Preparation of Sulfidized Red Mud Using Sodium Sulfide (Na_2S). The procedure of Example 2 was repeated using sodium sulfide instead of ammonium sulfide.

SRM 6. Preparation of Sulfidized Red Mud Using Calcium Polysulfide (CaS_x). The procedure of Example 2 was repeated using 33.5g of 30% solution of Cascade, calcium polysulfide.

Table 1. Sulfur Content of RM-1 and SRM (2-6)

CODE	DESCRIPTION	EXAMPLE	S (wt%)
RM-1	Red Mud	1	0.19
SRM-2	Sulfidized Red Mud H_2S	2	0.48
SRM-3	Sulfidized Red Mud H_2S with Pressure	3	0.90
SRM-4	Sulfidized Red Mud $(NH_4)_2S$	4	0.46
SRM-5	Sulfidized Red Mud Na_2S	5	0.62
SRM-6	Sulfidized Red Mud CaS_x	6	1.19

A more complete analysis of RM-1, SRM (3-6) is given in Table 2. The analysis reveals that filtration and washing during preparation of sulfidized red mud extracts sodium chloride (except for SRM-5) and increases concentration of Fe_2O_3 in red mud. It is significant that very small amounts of reacted sulfur have such a strong effect on the chemical and physical properties of red mud.

Table 2. Analysis of RM-1, SRM (3 -6).

		Weight %						PPM		
CODE	DESCRIPTION	Na_2O	MgO	Al_2O_3	SiO_2	P_2O_5	Fe_2O_3	Cr	Pb	Cu
RM-1	Control	4.73	0.12	17.1	8.23	1.14	39.9	1258	144	119
SRM-3	H_2S (b)	3.94	0.14	14.6	9.14	1.38	46.2	1506	180	138
SRM-4	$(NH_4)_2S$	4.39	0.13	17.9	9.24	1.26	42.3	1379	176	146
SRM-5	Na_2S	5.20	0.11	17.2	8.41	1.29	41.5	1272	159	130
SRM-6	CaS_x	4.44	0.09	16.2	8.41	1.29	41.2	1364	165	138

Leaching of RM-1 vs. SRM-2. In part (a), a slurry of red mud (50g) and demineralized water (450ml) was prepared, mixed for 30 minutes, and filtered. The filtrate was acidified with 2ml concentrated nitric acid and analyzed by ICP using EPA3050 and EPA6010 methods. In part (b), the procedure of part (a) was repeated using sulfidized red mud (SRM-2). Results are given in Table 3 and show that leachate from sulfidized red mud (SRM-2) gave a much reduced content of heavy metals (low parts per billion) than leachate from the red mud (RM-1) in every case, except Cd, where the difference was insignificant.

Table 3. Metal Concentration in Leachate (ppm)

	Hg	As	Cd	Cr	Pb	Se
SRM-2	0.0026	ND*	0.0013	0.0044	ND	ND
RM-1	0.0032	0.096	ND	0.0510	0.0064	0.017

*ND – Not detectable, below limits.

Mercuric Solution (3.5ppm) Sorption by SRM-3. Ten grams of sulfidized red mud SRM-3 was slurried 30 minutes with 1kg demineralized water containing 3.5ppm mercury (5.66ppm mercuric nitrate). The slurry was filtered and analyzed for mercury (Hg^{++}) by ICP (Method EOA 245.1).

The procedure was repeated using 22.0 ppm and 41.0 ppm mercury solutions (11-12), (13-14).

Results of tests 9-14 are summarized in Table 4 and demonstrate the superior performance of sulfidized red mud compared to red mud for sorption of mercuric ion from aqueous solutions.

Table 4. SRM-3 vs RM Mercuric Ion Sorption from Aqueous Solutions

Example	Mercuric Concentration in Filtrate	% Sorbed
Control Solution	3.5 ppm	
9 RM-1	0.56 ppm	84
10 SRM-3	0.2 ppm	94.3
Control Solution	22.0 ppm	
11 RM-1	8.0 ppm	64

12 SRM-3/	0.22 ppm	99
Control Solution	41.0 ppm	
13 RM-1	23.4 ppm	43
14 SRM-3	0.04 ppm	99.9

Example 15 Mercury (metal) Sorption from Vapor Phase by SRM-3 and RM-1 (Spray Absorbed). In part (a), one gram of mercury metal was placed in a two necked round bottom (RB) flask on a supported heating mantle. One neck of the flask was open and the second neck was connected with a Teflon® tube to an aperture in the inlet duct of a spray dryer. The mercury was heated to 300°C. A slurry of 580g SRM-3 in 450ml demineralized water was sprayed by a rotary atomizer operating at 30,000 rpm. The feed rate of SRM-3 was regulated to produce an outlet temperature of 100°C from the dryer.

In part (b), the procedure of part (a) was repeated using RM-1 instead of SRM-3. The mercury content of the spray dried SRM from part (a) and the RM from part (b) are tabulated in Table 5 and show that the SRM had a significantly improved sorption of mercury.

Table 5. Mercury Sorption by Spray Dried SRM-3 and RM-1.

	Sorbed Hg Concentration (ppm)
15 (a) SRM-3	61.0
15 (b) RM-1	8.1

SRM-3 absorbed 7.5 times more mercury as RM-1 when spray dried at 300°C inlet and 100°C outlet in the presence of an air stream containing mercury heated to 250°C. Sulfidized red mud is significantly superior to red mud as a sorbent for elemental mercury metal vapor.

Example 16 Mercury (metal) Sorption from Vapor Phase by SRM-3 and RM-1 (Spray Absorbed). Example 15 was repeated except that a slurry of 100g SRM-3(a) and also 100g of RM-1 in 900ml demineralized water were spray dried (b). Samples 16a and 16b were analyzed for mercury.

This experiment was then repeated using 100g RM-1 and also 100g SRM-3 to furnish samples 16c and 16d, which were analyzed. The results of tests 16(a) – (d) are shown in Table 6 below.

Table 6. Mercury Sorption from Vapor Phase

		Sorbed Hg Concentration (ppm)
16 (a) SRM-3	1st pass	95
16 (b) SRM-3	2nd pass	340
16 (c) RM-1	1st pass	43
16 (d) RM-1	2nd pass	48

As evident from Table 6, SRM-3 is about twice as efficient as RM-1 on the 1st pass and about seven times as efficient as RM-1 on the second pass. The results show that the affinity of SRM-3 for mercury vapor improves with increased exposure to mercury, indicating an induction effect.

Sorption of mercury by scrubbing gases with sulfidized red mud has important potential for reducing mercury contamination of both freshwater and saltwater bodies.

Table 7 below summarizes the results of Examples 19 – 28 using the general procedure of Example 9. The last column indicates the amount (in wt %) of the target ion that was removed by SRM. The results with thorium are especially significant.

Table 7. Summary of Examples 19-28 SRM-3 vs. RM-1

Example	Element	Control Solution ppm	RM-1 Filtrate ppm	SRM-3 Filtrate ppm	% Removed by SRM-3
19	Chromium III	2.740	0.018	0.005	99.8
20	Copper II	1.550	0.028	<0.004	99.99
	Copper II	6.250	0.054	0.038	99.4
	Copper II	30.50	0.073	0.040	99.9
21	Zinc II	1.850	0.035	0.009	99.5
	Zinc II	2.380	0.103	0.022	99.1
22	Silver I	3.15	ND*	ND**	99.99
23	Gold I	0.703	ND	0.227	67.7
24	Cadmium II	1.850	0.035	0.009	99.5
25	Lead II	2.0	0.058	0.007	99.7
26	Selenium	2.5	2.1	0.24	90.4
27	Thorium IV	0.956	0.054	ND	99.99
	Thorium IV	4.93	0.260	ND	99.99
	Thorium IV	10.50	0.564	ND	99.99
	Thorium IV	19.40	0.921	ND	99.99
28	Uranium II	1.13	0.074	0.04	96.5
	Uranium II	10.1	2.45	0.494	95.1
	Uranium II	38.0	6.90	3.95	89.6

***ND: Not detectable.**
****ND: Essentially quantitative removal of Thorium was obtained by SRM-4.**

Example 29 Comparison of SRM and RM for Sorption of As, Co, Mn, and Sr. The procedure of Example 9 was repeated using solutions of arsenic (III), arsenic (V), cobalt II, manganese (II), and strontium (I), with results summarized in Table 21.

Table 8. Comparison of SRM-3 and RM-1 sorption

Element	Control Solution ppm	RM-1 Filtrate ppm	% Removed	SRM-3 Filtrate Ppm	% Removed
Arsenic III	0.60	0.11	81.6	0.36	40
Arsenic V	1.60	0.21	86.9	1.15	28
Cobalt II	2.75	0.013	99.5	0.046	98.3
Manganese II	1.63	0.135	91.7	0.548	66.4
	2.10	0.72	65.7	0.792	62.3
Strontium II	1.90	0.10	94.7	1.10	42.1
	9.0	0.08	99.1	4.60	48.9
	27.0	0.19	99.3	11.0	59.3

These experiments reveal that sorption of red mud (RM-1) is significantly better than SRM-3 in the case of As (III), AS (V), Mn (II), and Sr (II). However, the use of red mud as a sorbent is restricted by leaching of undesirable elements which can cause serious problems. Use of sulfidized red mud in combination with red mud is useful because sulfidized red mud prevents undesirable leaching of toxic metals from red mud itself.

Example 30 Sorption of Hg (II) by Various SRMs. Summarized in Table 9 below.

Table 9. Sorption of Hg(II) by SRM (3-6)

	Concentration of Hg(II) in Original Solution (ppm)	Concentration After treatment With SRM (ppm)	% Removed
SRM-4	4.5	0.001	100
5% $(NH_4)_2S$	19.6	0.0229	99.9
SRM-5	4.5	0.449	90.0
5% Na_2S	19.6	3.68	81.2
SRM-6	4.5	0.005	99.9
5% CaS	19.6	3.16	83.8
SRM-3	4.5	0.004	99.9
H_2S pressure	19.6	0.02	99.9

SRM-3, 4, and 6 gave excellent sorption results from solutions of Hg(II) at two concentrations (4.5 ppm and 19.6 ppm). It is significant that SRM-4 reduced Hg to 1 ppb, thus meeting current drinking water standards (3 ppb maximum).

Ammonium sulfide treatment red mud (SRM-4) was the most effective sorbent despite the fact it had the lowest S content. SRM-5 prepared by treatment of red mud with Na_2S was much less effective than SRM-4.

Example 35 Sedimentation Rates of SRM-4 and RM-1. In the course of tests on metal sorption from aqueous solutions by sulfidized red mud and red mud, it was found that in all cases, sulfidized red mud exhibited significantly faster filtration rates than red mud. Red mud is very hydrophilic but conversion of red mud to sulfidized red mud transforms it to a lyophobic sorbent which is more readily dewatered. The unexpected improvement of dewatering behavior is shown in the following experiment.

A dispersion of 50 grams of RM-1 in 500ml demineralized water was prepared by rapid mixing in a Waring Blender for 10 minutes. The experiment was repeated using 50 grams of SRM-3 in 500ml demineralized water.

Both freshly prepared slurries were allowed to settle undisturbed at ambient temperature (25°C) for a period of 23 hours. After 23 hours, the RM-1 dispersions had settled to give a clear supernatant layer of only 1cm. The remaining slurry consisted of dispersed RM-1 with no visible sediment.

During a 23 hour period, the SRM-3 slurry settled to furnish a sedimentary layer about 3cm deep and a clear supernatant layer 11.5cm above the sediment.

These results clearly show the significant alteration of surface chemistry and dewatering characteristics of red mud by relatively small degrees of sulfidation.

Figure 1 Sedimentation.

Example 36 Clarification of Okefenokee Swamp Water with SRM-4. 500ml of Okefenokee Swamp water (Sample I) was adjusted to pH7 with dilute NaOH and mixed with 10 grams of SRM-410 (made with 10% ammonium sulfide) in a Waring Blender at high speed for 5 minutes. The mixture was transferred to a beaker and allowed to stir an additional hour using a magnetic stirrer.

The suspension was filtered and the color value of the filtrate was determined with a LaMotte TC-3000e colorimeter. Another 10 grams of SRM-410 was then added and the procedure was repeated a second time (2nd Pass). The filtrate was again evaluated for color. Results are given in Table 26 and showed that the treated sample was nearly colorless (over 90% reduction in absorbance).

Table 26. Absorbance Testing of Okefenokee "Black" Water (Sample I)

Sample Designation	Color Value (CV) (375nm)
Control Untreated	247
1st Pass SRM-410	38.9
2nd Pass SRM-410	18.8

Another sample of Okefenokee "Black" Water (Sample II) was treated with sulfidized red mud according to the above procedure. The absorbance was reduced 90% to nearly colorless as shown in Table 27 (2 passes) and Figure 2.

Table 27. Okefenokee "Black" Water (Sample II)

Sample Designation	Absorbance[1]
Control Untreated	0.063
Sample II	0.0063

[1]Fisher Genesys5 Spectrophotometer 500nm

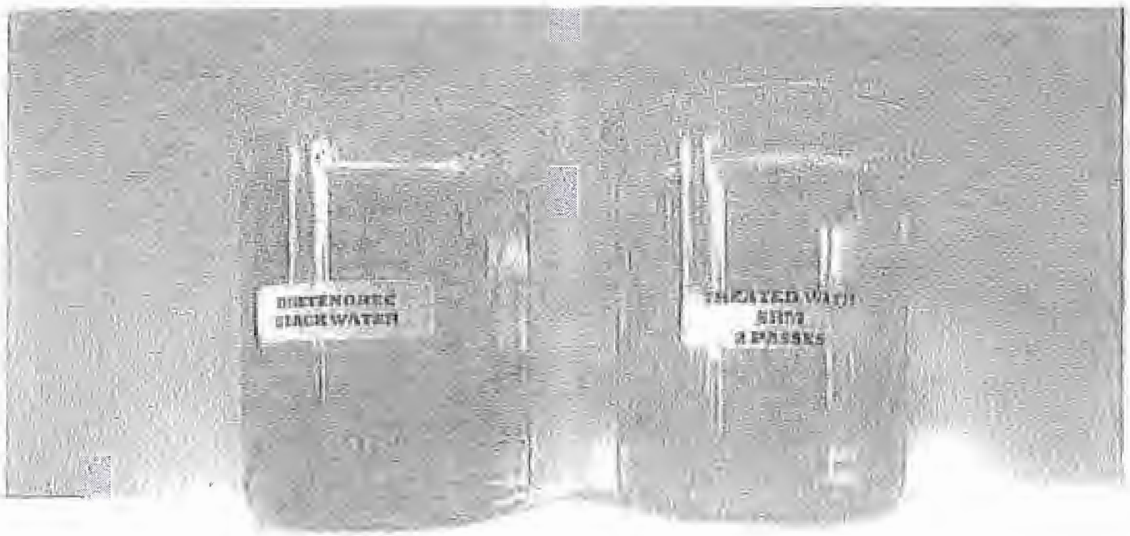


Figure 2 Okefenokee "Black" Water DOC Removal.

REFERENCES

Forbes Magazine 2003, April edition page 104

Iannicelli 2010: Method and Composition for Sorbing Toxic Substances/Flue Gas Scrubbing USPTO Publication 2010/0218676 A1.

Iannicelli 2010: Method and Composition for Sorbing Toxic Substances/Combination of Red Mud and Sulfidized Red Mud USPTO Publication 2010/0224567 A1.

Iannicelli 2010: Method and Composition for Sorbing Toxic Substances/Accelerated Sedimentation of Sulfidized Red Mud. USPTO Publication 2010/0224576 A1.

Iannicelli 2010: Method of Sorbing Discolored Organic Matter (DOC) by Sulfidized Red Mud (Sorbing DOC with Sulfidized Red Mud). USPTO Publication 2010/0243568 A1.

Iannicelli 2010: US Patent No 7,763,566 B2 Method and Composition for Sorbing Toxic Substances.

Iannicelli 2010: US Patent No 7,807,058 B2 Method and Composition for Sorbing Toxic Substances/Filter.

MConshie, David 2005: cites from Virotec website: virotec.com/global.htm.

Ryle, Gerard 2002: *The Great Red mud Experiment that Went Radioactive*

Tedder, D. William 1984: *Bauxite Residue Fractionation with Magnetic Separators*, Chapter 33 AIME Bauxite Symposium.

AQUAFINE

MUD MAN Iannicelli poses with a sample of his sulfidized red mud sorbent, called Azorb.

MAKING THE MOST OF RED MUD

An octogenarian chemist's latest invention turns hazardous aluminum mining waste into a material for **CLEANING UP WATER**

STEPHEN K. RITTER, C&EN WASHINGTON

JOSEPH IANNICELLI is an inventor unlike any other you might have met. He is the 84-year-old president of Aquafine Corp., a Brunswick, Ga., company that supplies spray-drying and magnetic separation equipment and provides laboratory services for industrial mineral processing. Iannicelli holds dozens of patents for technologies used to purify kaolin, a white aluminum silicate mineral that is essential to making paper, cosmetics, paint, and sorbents for water treatment.

Iannicelli has amassed a small fortune since he graduated from Massachusetts Institute of Technology with a Ph.D. in organic chemistry back in 1955, when he helped develop a biosynthetic method to make penicillin. After working for DuPont on textile fiber polymers and for J. M. Huber Corp. on kaolin, he launched Aquafine in 1971.

In conversations, Iannicelli spontaneously recalls the details of his diverse inventions. His firm baritone leaves the listener hanging on his every word as he weaves a tale to explain how he lately came to be interested in playing with red mud.

Known formally as bauxite residue, red mud is the noxious by-product of the Bayer process for extracting aluminum from bauxite ore. Aluminum mining leaves behind a staggering 120 million metric tons per year of the salty, highly alkaline, heavy-metal-laden material, according to the International Aluminium Institute, a London-based trade organization. The aluminum industry has long tried to find ways to recycle the environmentally problematic red mud. But so far there have been few safe and economical large-scale applications.

"Red mud is a curse," Iannicelli observes. "There is no shortage of simple, ingenious solutions for dealing with most categories of environmental pollution, including red mud. The deciding factors on implementation are cost and safety."

Iannicelli's solution for red mud is to treat the abundant material with cheap sulfur compounds. Doing so locks in trace metals and improves the material's sorbent properties, he says, so it can be used for cost-effective wastewater treatment and in other environmental remediation applications. He calls the sulfidized red mud Azorb.

In the Bayer process, strip-mined bauxite is treated with hot caustic soda (sodium hydroxide), which selectively dissolves aluminum from an array of other mineralized metals. The end product is alumina, Al_2O_3, which is the feedstock for producing aluminum metal.

But for every ton of alumina extracted, more than a ton of red mud is produced. Bauxite processors recycle the caustic soda and pump the residual red sludge into huge settling ponds. When as much water is removed as possible, the material can be chemically treated to lower the pH and planted over with vegetation.

The scourge of red mud burst into the public's eye in October 2010 when a settling pond in Hungary ruptured. A flash flood of red sludge gushed through several small towns, killing 10 people by drowning and injuring more than 100 others by burning their skin and irritating their eyes and lungs.

Iannicelli isn't the first person to think about getting his hands dirty with red mud to help prevent such disasters. Australia-based industrial waste management firm Virotec has developed a process to neutralize red mud with copious amounts of seawater or brine. The resulting material is generally used to remediate mining sites, but it is also used as filler to make bricks and as a sorbent to trap metals and phosphorus in wastewater.

Aluminum producer Alcoa has a process to carbonate red mud using CO_2 from industrial gas streams. The resulting "red sand" is used to make cement and in road construction. Others have developed processes to recover iron and rare-earth metals from red mud. But so far, only 2 million metric tons of red mud is being repurposed annually—less than 2% of the amount being generated.

ONCE ALUMINUM is extracted from bauxite, the remains are a porous matrix of metals—a mineral skeleton, Iannicelli explains. As much as half of red mud is iron oxide, from which it gets its rusty color. Other major components include aluminum, silicon, titanium, calcium, and sodium oxides. The material includes trace amounts of other metals, including radioactive uranium.

With a high surface area, red mud is a natural sorbent capable of grabbing heavy metals and organic contaminants and sequestering them. But red mud can also leach toxic heavy metals, which is an environmental concern.

Iannicelli's sulfidation process involves treating red mud with sulfur compounds under ambient conditions or with mild heating. Any of a number of sulfur compounds will do the job, he says, including Na_2S, $(NH_4)_2S$, and H_2S. In the sulfidation reaction, sulfur atoms bind to vacant spots on metals throughout the skeletal network, locking the metals into place and preventing them from leaching.

Sulfidation also tunes the red mud so

that it has significantly higher sorbent capacity than untreated red mud, Iannicelli says. He has been testing Azorb's sorbent capabilities in side-by-side tests with untreated red mud using solutions of different metal salts.

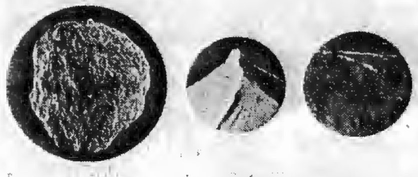
Azorb removes better than 90% of most metals from aqueous solutions, Iannicelli says. His team has achieved better than 99% removal rates for metals of concern such as cadmium, chromium, lead, and mercury. The sulfidized red mud is not as efficient at removing arsenic, manganese, and strontium as red mud itself, Iannicelli says. But he suggests mixtures of red mud and sulfidized red mud might be an option for some applications. Once used, the material would be placed in a landfill.

"This work is certainly a very interesting study to detail the removal of a wide range of different species," says Justin Hargreaves, a chemist at the University of Glasgow, in Scotland. "Particularly interesting is that consideration has been given to the possibility of the red mud systems being sources of contaminants themselves and the application of sulfided and nonsulfided red mud combinations to optimize removal efficacies."

Hargreaves and his colleagues have been treating red mud with methane, a readily available by-product of oil refining and landfills. Red mud catalytically decomposes methane to form hydrogen and an iron-carbon composite. The Glasgow researchers think the inexpensive magnetic composite material could be used to remove impurities such as arsenic and chromate from drinking water in developing countries.

BY COMPARISON **As a rule of thumb, 4 metric tons of bauxite yields 2 tons each of alumina and red mud, and in turn 1 ton of aluminum metal.**

Global production in 2012, metric tons



SOURCE: International Aluminium Institute

INTERNATIONAL ALUMINIUM INSTITUTE (BAUXITE, ALUMINA), SHUTTERSTOCK (CAN, RED MUD)

Iannicelli has also tested Azorb to clean up water discolored with natural dissolved organic compounds, such as tannins and lignin. This is a problem encountered when the effluent of pulp and paper mills is discharged into rivers. Although such water isn't always considered polluted, when water clarity is unnaturally impacted the effluent is in violation of the intent of clean water laws.

With that in mind, Iannicelli has shown that Azorb readily traps and removes discolored compounds from Okefenokee Swamp water. Iannicelli also has been working with Altamaha Riverkeeper, a nonprofit environmental stewardship organization that is concerned with discolored water in the Altamaha River, which drains central Georgia. The discolored water there mostly comes from a Rayonier wood pulp mill that manufactures cellulose fibers used in plastics and as an absorbent material in products such as diapers. In preliminary tests on the river water, Azorb removed the discolored compounds, Iannicelli says.

Iannicelli also owns a colonial-era rice plantation in Georgia. The plantation is no longer farmed, but it is home to a mobile home park that has its own wastewater treatment facility. As a licensed wastewater engineer, Iannicelli has carried out water treatment tests using Azorb. His team found that Azorb removes phosphorus and fecal coliform bacteria, the major contaminants of concern in wastewater, to below detection levels.

Not content to stop there, Iannicelli had technicians with the Jekyll Island State Park Authority in Georgia test Azorb on municipal wastewater. They obtained similar results, providing an independent confirmation of phosphorus and bacteria removal.

Iannicelli has also talked with scientists at a large coal-fired power plant about the prospects of using Azorb to remove mercury and selenium, the two metals of greatest concern in scrubber gas wastewater.

"There is a long history of attempts to

"Red mud is a curse."

reformat red mud for beneficial use, with none to my knowledge having proved successful on a large scale," says Ian T. Burke, an environmental scientist at the University of Leeds, in England. Burke remains skeptical that the abundant red mud can safely be used.

Last year, Burke led a team that took a look at three of the most hazardous trace metals in the Hungarian red mud: arsenic, chromium, and vanadium. The researchers found that arsenic and chromium are not in bioavailable states and posed low risk. But vanadium is in the bioavailable V^{5+} state and could be a long-term problem.

"MANY STUDIES that deal with red mud as an absorbent focus on the uptake of metals or nutrients," Burke continues. "But they do not give enough consideration to the quality of the treated water—that is, is it suitable for discharge to rivers?"

Burke also has questions about the long-term stability of new mineral phases in the sulfidized material and how it will hold up when used as a sorbent. "Much more detailed work seems to be required before this material could actually be used," Burke believes.

Futility has been the name of the game with red mud, adds geologist Katy Tsesmelis, a communications manager at the International Aluminium Institute. "We receive lots of project proposals that may have a sound scientific basis but could never be scaled up," Tsesmelis notes. She says there are also lots of attempts made to reuse red mud that never come to light. It's possible someone already tried sulfidized red mud.

But Tsesmelis emphasizes that the industry continues to invest in research. "The industry as a whole is working hard to remediate and reuse bauxite residue."

Iannicelli isn't discouraged by the lack of success so far in using red mud. He now has multiple patents for the sulfidation process and is eager to make commercial quantities of Azorb. He expects the cost to be as little as 10 cents per lb, less than half the cost of similar sorbents. And the first major application might be this year, cleaning up discolored pulp and paper mill effluent.

"I think the time is ripe to turn cheap red mud into an inexpensive material that can help solve some serious environmental problems," Iannicelli says. "I don't have all the answers yet. But as a chemist, I want to do good for the chemical industry." ■

kson, Galo

n:	gec@glynnenvironmental.org
t:	Monday, March 16, 2015 1:26 PM
	Jackson, Galo; Johnston, Shelby
	environsc@gmail.com
ject:	LCP Site Proposed Plan - GEC and Community Comments
chments:	ESC LCP PP EPA Comments final.pdf; ESC LCP PP Comments final Appendices.pdf

Iackson and Ms. Johnston,

community met with Dr. Peter deFur, on December 4, 2014 to discuss the Proposed Plan for the Marsh at the LCP nicals Superfund Site. At that time, numerous questions were asked by the community and since the meeting many e questions have been directed to Dr. deFur. Over the past several months, Dr. deFur, in his capacity as our munity's technical advisor under the EPA Technical Assistance Grant program has responded to many comments, esses several issues. In addition, Dr. deFur has helped the community identify questions for which we are unable to answers. To a large extent, the attached comments and questions are a result of this process, and our community's rt to understand the LCP Site documents and find the underlying data in support of the Proposed Plan.

Glynn Environmental Coalition is submitting the questions and comments Dr. Peter deFur has helped our munity develop so we can be involved in the Superfund Site decision-making process.

se do let us know if you have any questions or have any problems receiving or opening the documents.

iel Parshley, Project Manager
:e – 912-466-0934
– [redacted]

Exemption 6 Personal Privacy

ickson, Galo

om: [redacted]
nt: Sunday, March 08, 2015 1:57 PM
: Jackson, Galo
ibject: LCP Chemicals Superfund Site Proposed Plan for the Marsh

citizens of Brunswick GA and a board members of Glynn Environmental Coalition we would like to ask for your :ention to the subject project please. We are concerned that there are no measurable goals, timelines to reach goals alternative plans to implement if goals are not reached. Goals should include seafood safe to eat, mink once again ing at the LCP site and dolphins health improving.

ditionally, cleanup was based on a study with only 4 percent African American participants despite the indisputable :t that 70 percent of the population for 1.5 miles around the LCP site is/was African American.

e plan completely ignores the marsh grass that accumulated PCBs in the root, rhizome, stem, leaf and detritus and cretes Mercury.

e Plan ignores Dioxin/Furan contamination and all the past data in fish and sediments and argues it is not needed sed upon observations from a lake 1,000 miles away in Syracuse NY!

otection of people has been ignored for over twenty years. Totally ignored. Cleanup of all PCBs and Mercury is most cessary since the EPA has failed to show competence to implement recommendations issued by health agencies for e past twenty years.

e are confident that if you give this issue your consideration you will see that there is only way this project should ogress if the interests and health of all living things are to be protected in a fair and just way.

ry truly yours, **Exemption 6 Personal Privacy**

[redacted]

Exemption 6 Personal Privacy

:kson, Galo

---

n: [redacted]>
t: Saturday, March 07, 2015 10:01 PM
Jackson, Galo
ject: LCP CHEMICALS SUPERFUND SITE PROPOSED FOR THE MARSH

r Mr. Jackson,

ıve lived on St. Simons Island, GA for over 30 years, which is only a few miles from the cleanup site, so I feel that I can ak as a "local" when it comes to writing to you about my concerns with the proposed cleanup plan of the LCP micals site.
ry to be brief.

Nhat are your goals with the cleanup? Is it possible to have healthy wildlife, fish, and dolphins once you've finished ı this work?

Nhat happens with the site once you all have finished cleaning up your proposed area? Will you come back and test area for the dangerous chemicals as long as there is still contaminants present?
This needs to be clearly stated in the proposal. If it's there, I haven't found it. You need to monitor this site; it's not to any of us who live here for it to be a one-time job. We desperately need this entire place cleaned up; not just a ıll area.

t is my understanding that the marsh around the site is contaminated with mercury and PCBs. If this is true, then all marsh should be removed,

Nhat is the medical risks to women as far as the continued contamination that you will NOT be cleaning up?

ıse ask yourself if you would be willing to live anywhere near this site.

;ards,

Exemption 6 Personal Privacy

[redacted]

ckson, Galo

Exemption 6 Personal Privacy

ım: [redacted]> ✓
ıt: Sunday, March 08, 2015 8:40 PM
Jackson, Galo
ɔject: more thoughts and concerns about the superfund cleanup site

ır Mr. Jackson,

terday evening I sent an email to you about LCP Chemicals contamination cleanup in Brunswick, Georgia. I have some litional thoughts and concerns.

l the EPA require annual monitoring for mercury and PCBs in all the fish (whole fish and fillets) that people eat and ı that dolphins, mink, raccoons, otters, estuarine turtles, snails, and fiddler crabs eat? If not, why not?

next questions are:

at monitoring has the EPA conducted on a regular basis for the past 20 years?

at monitoring data is the EPA using to compare before and after the cleanup and coverup of the contamination?

en will the EPA evaluate the cleanup (dates for evaluation, and how frequent will the EPA evaluate), what will be the cific evaluation factors (numerical goals) and specifically what will be done if the numerical goals are not reached?

at will fiddler crabs do to the thin layer cap?

nk you in advance for your time; I look forward to hearing from you with answers to all my thoughts and concerns.

ards,

[redacted] Exemption 6 Personal Privacy

ckson, Galo

Exemption 6 Personal Privacy

m:	[redacted]>
nt:	Saturday, March 07, 2015 10:21 PM
	Jackson, Galo
oject:	LCP Chemical site cleanup

ır Mr. Jackson,

re are some concerns I have with the proposed cleanup at the contaminated LCP Chemical site.

n't understand the longterm goals of your work.

Are you only going to cleanup a small area within the poisoned, contaminated site?
What is the point of only doing this area? The whole contaminated area needs to be cleaned up.
I haven't seen where you will be back to monitor your work. You need to monitor this entire site for years.

ınt to see healthy fish, dolphins, turtles, and animals freely roam this marsh and water. That is my goal and it should EPA's goal also.

ı sincerely asking for long-term site monitoring; don't leave us high and dry with acres of still contaminated marsh water.

ar as the thin layer cover, I think that's just a trick. Have you seen our strong tides? How could this possibly work for length of time?

ve been a resident of St. Simons Island for a long time and consider myself as a very concerned citizen. Please onsider your proposal and ask yourself is this really a credible cleanup of one of the most contaminated sites in the ted States!

ards,

Exemption 6 Personal Privacy

[redacted]

[redacted]

Exemption 6 Personal Privacy

March 16, 2015

r. Galo Jackson, Remedial Project Manager
uth Superfund Remedial Branch
S. EPA Region 4
Forsyth Street, SW
lanta, GA 30303-8960

ear Mr. Jackson

ie purposes of this letter are to request information, submit questions, and offer comments on the opose Plan for the LCP Chemicals Superfund Site. I expect these and any responses to be included in e official records of the Plan.

Exemption 6 Personal Privacy

[redacted]

ttended the first Public Comments session you held in Brunswick last November. I have studied the oposed Plan documents as well as the materials submitted to you by Daniel Parshley for the Glynn ıvironmental Coalition (GEC). I have three topical areas to cover in this communication:

- The GEC's responses to the Plan;
- The hydrodynamic model(s) used in the Plan;
- The economic issues raised by the Alternatives in the Plan.

he GEC Submissions

full-heartedly endorse the submissions of the GEC and Mr. Parshley. They are supported by years of perience in the field, the area, and the specific LCP Site. They reflect current and well gathered data d applicable published research. They provide important, even critical, considerations and corrections the Proposed Plan. With these inputs, you should be able to make needed amends to the Proposed lan. The pollutants involved will outlast you and I by several generations. Therefore, we should be orking together to protect this environment.

he Hydrodynamic Model (HDM)

the initial version of the Proposed Plan, there were a couple of off-hand mentions of such a model. In e Public Comments meeting, both you and one of your staff present indicated that you used a ydrodynamic model to test the proposed and recommended remediation design. I questioned this

›del and you indicated it was standard for EPA. I expected that the follow-up from the meeting would ›vide details but, so far, nothing has shown up.

ıe EPA Region IV website provides only two such models. Both are supposed downloadable from the e. One is one dimensional, according to the site. The other is supposed to be one, two, or three nensioned according to the model user's selection. One model is validated by two western Georgia ers while the other is validated by a North Carolina river that flows into the Atlantic Ocean without y indication of a mediating tidal Spartina marsh. It appears, therefore, that the hydrodynamic models ailable to EPA are of little or no applicability to the LCP site. ***Is this the correct situation?***

my career, I have used many and written some quantitative, statistical models. To use a model, it is cessary to identify the model's authorship, ownership, and the revision level used. ***What is the digree and version of the HDM(s) used in the Proposed Plan?***

henever I've used a model formally, including in court testimony and published research reports, I ve always taken pains to itemize the parameter settings and the data fed into produce the reported sults. For example, you might have set minimum and maximum air temperature parameters and used set of Weather Bureau temperature data to run the HDM for the Plan. ***What were the parameters used id what was the data set(s) used in the HDM to test the recommendations?***

ıe Proposed Plan shows several maps of the LCP site and its surroundings to show where core samples r different pollutants were taken. I believe that sample sites numbered in excess of 80. ***Were the mple sites predicted by the HDM's estimate of where pollutants spread since the initial mediation? Is this why the sampling was performed at the LCP site? If so, how well did the HDM edict the spreading? If not, why not?***

he remediation for the LCP site will need to address the long run effects, likely for century or more. ***hat does the HDM predict into the long future? What time horizons have been tested on the HDM? ill the results be reported in the Final Plan document?***

ased on the HDM modeling, how complex and how frequent will future sampling be required?

hile the Glynn coast has tended to be missed by many hurricanes, sooner or later it will be hit. When is, it could get hit by a "perfect storm" – a nor'easter and a hurricane. The storm surge could be vesome. If such a surge coincides with high tide, there will be major effects deep inland. ***What does ıe HDM predict will be the pollution outcomes of such a storm? How will the capping and nchoring of the Proposed Plan hold up?***

he Economic Considerations

he Proposed Plan offers six Alternative remediation scenarios and recommends #6. Yet, it appears ıat, ignoring #2 – the all-out costly option, the highest cost is only a quarter more than #6 ($28M → 34M). This appears to provide remediation of three times more polluted area, up to 48 acres. ***Why was ıe cheaper Alternative selected when a cheaper per acre option would provide more remediation?***

he Proposed Plan does not seem to address the social and governmental issues to sustain coping with ıe continued effects of polluting sediment at the LCP site. The only mentions of social adaptation are) to put signs around the capped area and b) to put Do-Not-Eat warnings on the fishing website. ***Who going to check and maintain the signage? Who is going to remind DNR to keep warning shermen?***

ɔactive steps should be provided for, as well. For example, EPA address the Brunswick City Council
d the Glynn County Commission after each general election that the LCP site is hazardous and not
ed for recreation or development. Likewise, police and game wardens need to be regularly reminded
the dangers. Perhaps, these could be done on a two year cycle.

mpling needs to be done to check that the remediation is working. This could be on a four or five
ar cycle. Superfund money should be allocated but it would be more sustaining if the State carried out
: sampling. In any case, the results should be reported to the public with each cycle.

---

conclude, thank you for your attention to these points. And thank you in advance for your responses
my questions and your follow thru to perfect the Plan. It is sad that earlier generations so abused the
h resources and beauty of this environment. Together, we can do better.

ıcerely and cordially,

[redacted]

Exemption 6 Personal Privacy

: D.Parshley, GEC

USE THIS SPACE TO WRITE YOUR COMMENTS

Your input on the Proposed Plan for the LCP Chemicals marsh important to EPA. Comments provided by the public are valuable in helping EPA select a final cleanup remedy for Operable Unit 1 of the Site.

You may use the space below to write your comments, then fold and mail. Comments must be postmarked for receipt by EPA no later than February 2, 2015. If you have questions about the comment period, please contact Mr. Galo Jackson, 404-562-8827. Those with electronic communications may submit their comments to EPA at the following email address: ~~jackson.galo@epa.gov~~ on or before February 2, 2015. **Note: In order to permit the community ample time to review and comment on this Proposed Plan, a 30 day extension to the initial 30 day comment period has been allowed for, concluding the comment period on February ~~2, 2015~~.**

One would think that an agency of the Federal Government has the resources and capacity to update public communications. The failure to do so is indicative of the general disregard exhibited towards the public by the regulatory agencies. This is not new. If the general welfare of the people and the health of the environment had been properly valued long ago, we would not now be dealing with accumulations of toxic wastes and a poisoned atmosphere.

That the fish are not fit to eat, the waters are not clean enough to drink and the air to breathe is unconscionable. Issuing advisories to the public that they should stop eating, drinking and breathing is unacceptable — as unacceptable as the Republican health care plan to "die quickly."

A society which permits its members to die in the prime of life will not long survive.

Also, since mobility is one of the essential characteristics of organic existence, precluding human access to a particular terrain is not "protective".

The LCP Chemical site is contaminated. The contamination needs to be removed.

Name [redacted] ✓

Address [redacted]

City ST. SIMONS ISLAND

State GA.

Zip 31522

Exemption 6 Personal Privacy

Exemption 6 Personal Privacy

kson, Galo

ı:	[redacted]>
:	·londay, March 16, 2015 6:22 PM
	Jackson, Galo
.ect:	Clean up Brunswick/St. Simons please

· Mr. Jackson,

citizen and a resident of Georgia I urge to please clean up the toxic wetlands, rivers, waterways and surrounding in the Brunswick area.

:rucial to health of our children. We know that they are the most at risk for all of the obvious reasons. But the life that you and I both admire and adore is not expendable.

se commit yourself to reestablishing a healthy, clean environment.

ıectfully submitted.

: from my iPhone

Exemption 6 Personal Privacy

Exemption 6 Personal Privacy

ckson, Galo

m:	[redacted]>
nt:	Sunday, March 15, 2015 9:22 PM
	Jackson, Galo
bject:	Brunswick/St.Simons Isl. River Clean Up

Jackson, please make sure the EPA takes measures to thoroughly clean up the toxic chemical sites around nswick/Saint Simons Island Georgia that affect our rivers, Saint Simons Sound, the soil and ground/drinking water ich spreads like underground rivers, and of course seriously affects our health and all children in the area.

cerely,
[redacted]

Exemption 6 Personal Privacy

ckson, Galo

m: [redacted]
nt: Monday, March 16, 2015 12:14 PM
Jackson, Galo
bject: GA

ar Mr. Jackson,
ase make sure the EPA takes measures to thoroughly clean up the toxic chemical sites around Brunswick/Saint ions Island that affect our rivers, Saint Simons Sound, the soil and ground/drinking water which spreads like lerground rivers, and of course seriously affects our health and all children in the area.
cerely,
[redacted]
it from my iPhone

Exemption 6 Personal Privacy

:kson, Galo

m: [redacted]>
:t: Monday, February 09, 2015 11:03 AM
Jackson, Galo
ject: Glynn County

ge you to take every measure to clean up the toxic mess that has been made of my beautiful childhood home. ; disgraceful what companies like LCP have done. I will be keeping an eye on the situation and spreading the :d reporting your success in this matter. Thank you

Exemption 6 Personal Privacy

:kson, Galo

---

n:	[redacted]>
t:	Tuesday, March 03, 2015 6:59 PM
	Jackson, Galo
	Glynn Environmental Coalition
ject:	Please make sure my homeland is protected

[redacted] I lived in Glynn County until [redacted] We vacation there often and look forward to fishing and crabbing. [redacted] I am aware of the great contribution industry can make to a community. As a [redacted] the [redacted], I have experience to know, industry has a ponsibility to leave a community as clean as possible. Glynn county marshes were not polluted in area LCP built before LCP and LCP should clean up to an acceptable, livable level before clean efforts are stopped.

: are all stewards of this plant. Let us be good stewards.

[redacted]

Exemption 6 Personal Privacy

TO: GALO JACKSON
ENVIRONMENTAL PROTECTION AGENCY
61 FORSYTH ST
ATLANTA GA 30303

CLEANUP OF THE LCP SITE WILL NOT BE COMPLETE UNTIL TOXINS FROM THE CONTAMINATED MARSH ARE REMOVED FROM OUR FOOD CHAIN.
I WANT TO KNOW THAT THE SEAFOOD AND THE WATER IN MY COMMUNITY ARE SAFE FOR MY FAMILY AND ME.

Exemption 6 Personal Privacy

Exemption 6 Personal Privacy

NAME ______ ADDRESS ______

[redacted]

[redacted]

Exemption 6 Personal Privacy

March 16, 2015

Galo Jackson
U.S EPA Region 4
61 Forsyth Street, SW
Atlanta, GA 30303-8960
Jackson.galo@epa.gov

Mr. Jackson,

I am very concerned about the LCP Superfund Site documents NOT addressing the risks to a woman's health from the chemicals in the seafood. How these chemicals hurt the health of men and women is quite different, and it appears the EPA is using a "one size fits all" approach to human health and the cleanup at the LCP Chemicals Superfund Site.

At a minimum, the Human Health Baseline Risk Assessment should acknowledge polychlorinated biphenyls, also known as PCBs, and dioxin and furan chemicals are associated with women contracting endometriosis, a very painful disease. Very often, doctors perform a hysterectomy to prevent further instances of endometriosis along with removal of these growths in the abdomen.

The EPA extensively quotes a study conducted in the Brunswick, Glynn County area (DHHS, 1999), which found over 50% of the women surveyed had already had a hysterectomy. When considering the wide age range of women surveyed, this is a shocking statistic.

Will the EPA include information about how the chemicals at the LCP Chemicals Superfund Site can hurt a woman's health?

Will the EPA plan a cleanup that will reduce these chemicals to levels that will not cause endometriosis in women?

Will the EPA call in experts to assist the EPA in finding the level to clean up to that will end the risk of endometriosis from the LCP Chemicals Superfund Site?

The LCP Chemicals Superfund Site documenters do not appear to have any information about how the chemicals hurt woman's health. I have provided several references below for use in the EPA decision-making process and plan for cleaning up the marsh.

Will the EPA include these studies in the LCP Chemicals Superfund Site documents?

Will the EPA use these documents to plan a cleanup that not only protects men, but women, too?

Potera, C. Women's Health: Endometriosis and PCB Exposure. Environ Health Perspect. Jul 2006; 114(7): A404.
http://www.ncbi.nlm.nih.gov/pmc/articles/PMC1513298/
Toxicologist Elena De Felip of the Istituto Superiore di Sanità in Rome and her colleagues measured 11 PCB congeners that are most abundant in human tissue. In 80 women aged 20 to 40, the sum of all congeners was 1.6 times higher in the 40 women diagnosed with endometriosis than in controls. Three congeners, PCBs 138, 153, and 180, were particularly higher in women with endometriosis. These three congeners have been reported to have estrogenic activity and to interfere with hormone-regulated processes.
Bruner-Tran, K.L., Kevin G. Osteen, K.G., Dioxin-like PCBs and Endometriosis. Syst Biol Reprod Med. 2010 Apr; 56(2): 132–146.
http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2867352/
Specifically, if the majority of PCBs and other toxicants have limited activity, the TEQ may not correlate with disease status since a weak AhR agonist could limit the actions of a more potent compound. For example, using primary rat hepatocytes Chen and Bunce (2004) demonstrated that PCB 153, which binds the aryl hydrocarbon receptor (AhR) without inducing CYP1A1 transcription, has no impact on TCDD-mediated CYP1A1 induction when TCDD is present at low levels, but antagonizes the effects of a high dose treatment. Since PCB 153 binds the AhR, this ligand will compete with TCDD for available binding sites, resulting in antagonism when all sites are bound. If more binding sites are present than can be occupied by all ligands, no competition exists; thus, depending on the activity of all ligands, there may be an additive, synergistic or no change in effect.
Louis G.M., Weiner JM, et al. Environmental PCB exposure and risk of endometriosis. Hum Reprod. 2005 Jan;20(1):279-85. Epub 2004 Oct 28.
http://www.ncbi.nlm.nih.gov/pubmed/15513976

Conclusion - These data suggest that anti-estrogenic PCBs may be associated with the development of endometriosis.

Thank you for your consideration of these comments on the Proposed Plan for the LCP Chemicals Superfund Site marsh.

Sincerely,

[redacted]

Exemption 6 Personal Privacy

Jackson, Galo

From: Jane Fraser <jfraser@ga.stutteringhelp.org>
Sent: Monday, March 16, 2015 10:50 AM
To: Jackson, Galo
Subject: LCP Superfund-Women's Concerns

March 16, 2015

Galo Jackson U.S EPA Region 4
61 Forsyth Street, SW
Atlanta, GA 30303-8960
Jackson.galo@epa.gov

Mr. Jackson,

I am very concerned about the LCP Superfund Site documents NOT addressing the risks to a woman's health from the chemicals in the seafood. How these chemicals hurt the health of men and women is quite different, and it appears the EPA is using a "one size fits all" approach to human health and the cleanup at the LCP Chemicals Superfund Site.

At a minimum, the Human Health Baseline Risk Assessment should acknowledge polychlorinated biphenyls, also known as PCBs, and dioxin and furan chemicals are associated with women contracting endometriosis, a very painful disease. Very often, doctors perform a hysterectomy to prevent further instances of endometriosis along with removal of these growths in the abdomen.

The EPA extensively quotes a study conducted in the Brunswick, Glynn County area (DHHS, 1999), which found over 50% of the women surveyed had already had a hysterectomy. When considering the wide age range of women surveyed, this is a shocking statistic.

Will the EPA include information about how the chemicals at the LCP Chemicals Superfund Site can hurt a woman's health?

Will the EPA plan a cleanup that will reduce these chemicals to levels that will not cause endometriosis in women?

Will the EPA call in experts to assist the EPA in finding the level to clean up to that will end the risk of endometriosis from the LCP Chemicals Superfund Site?

The LCP Chemicals Superfund Site documenters do not appear to have any information about how the chemicals hurt woman's health. I have provided several references below for use in the EPA decision-making process and plan for cleaning up the marsh.

Will the EPA include these studies in the LCP Chemicals Superfund Site documents?

Will the EPA use these documents to plan a cleanup that not only protects men, but women, too?

Potera, C. Women's Health: Endometriosis and PCB Exposure. Environ Health Perspect. Jul 2006; 114(7): A404.

http://www.ncbi.nlm.nih.gov/pmc/articles/PMC1513298/

Toxicologist Elena De Felip of the Istituto Superiore di Sanità in Rome and her colleagues measured 11 PCB congeners that are most abundant in human tissue. In 80 women aged 20 to 40, the sum of all congeners was 1.6 times higher in the 40 women diagnosed with endometriosis than in controls. Three congeners, PCBs 138, 153, and 180, were particularly higher in women with endometriosis. These three congeners have been reported to have estrogenic activity and to interfere with hormone-regulated processes.

Bruner-Tran, K.L., Kevin G. Osteen, K.G., Dioxin-like PCBs and Endometriosis. Syst Biol Reprod Med. 2010 Apr; 56(2): 132–146.
http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2867352/

Specifically, if the majority of PCBs and other toxicants have limited activity, the TEQ may not correlate with disease status since a weak AhR agonist could limit the actions of a more potent compound. For example, using primary rat hepatocytes Chen and Bunce (2004) demonstrated that PCB 153, which binds the aryl hydrocarbon receptor (AhR) without inducing CYP1A1 transcription, has no impact on TCDD-mediated CYP1A1 induction when TCDD is present at low levels, but antagonizes the effects of a high dose treatment. Since PCB 153 binds the AhR, this ligand will compete with TCDD for available binding sites, resulting in antagonism when all sites are bound. If more binding sites are present than can be occupied by all ligands, no competition exists; thus, depending on the activity of all ligands, there may be an additive, synergistic or no change in effect.

Louis G.M., Weiner JM, et al. Environmental PCB exposure and risk of endometriosis. Hum Reprod. 2005 Jan;20(1):279-85. Epub 2004 Oct 28.
http://www.ncbi.nlm.nih.gov/pubmed/15513976

Conclusion - These data suggest that anti-estrogenic PCBs may be associated with the development of endometriosis.

Thank you for your consideration of these comments on the Proposed Plan for the LCP Chemicals Superfund Site marsh.

Sincerely,

Exemption 6 Personal Privacy

Jane Fraser

[redacted]

,/2/15 [redacted] Comments to U. S. Environmental Protection Agency
..perfund Proposed Plan, LCP CHEMICALS SUPERFUND SITE, Operable Unit 1, Nov. 2014

ıtroduction

. This is where I learned about the Superfund process. When I told him I was moving to Brunswick, Georgia he recommended I seek employment with The only thing I recall him sharing with me about the Brunswick area was that they wanted to build a causeway from the North end of St. Simons Island through protected marshland (Jimmy Carter from Georgia served from 1977 to 1981 and the marshlands were being protected.) I gathered from what he said that it was never going to happen.

History

When I told my that I was moving to Brunswick, Georgia he said "Isn't that the place that stinks?" I didn't know at the time, but it turns out he was right. Even so, I had just been working for the Environmental Protection Agency and knew there were laws in place to protect the citizens so I didn't worry about it.

Subconsciously I must have worried. When my and I looked for a house we told the realtor that we wanted to live far enough away from Hercules that we didn't have to smell it. . The area north of us is the marshland that Mr. Zorc was referring to where they wanted to build a causeway.

My first child. . was born

About: ıe EPA shutdown the Hercules 009 Superfund site. I started following and clipping articles about toxic sites in Glynn County. What really surprised me at the time was that I could live in Brunswick, Georgia for a year and a half and never hear anything about polluted sites from friends, at college or at work.

In August of 1981 I was at the movies at Lanier Plaza next to the Hercules plant when I passed out. An ambulance was called; the emergency medical technician who checked me out said that I had probably just cut off my circulation from sitting too long –

. I should have realized when I left, and there was a young boy in the lobby having a seizure, that I had been exposed to something through the ventilation system. It wasn't until that child's permanent molars came through without enamel, and I was told that it was probably something that happened right before she was born or when she was

Exemption 6 Personal Privacy

very young that caused it, that I thought I had been exposed to something through the ventilation system. In those days our only two theaters in Glynn County were the one at Lanier Plaza and the Drive-in next to LCP, which I also went to.

I encountered a lady in the Kroger's grocery store. Who asked me what stunk. I told her what I believed at the time – Hercules, but it could have been the pulp mill. She was from up North and wanted to know what the community was doing about it. I started listing out all the reasons I had heard over the last couple of years about why nothing was ever done about it . . . jobs, retaliation, etc... And, then she asked me why I wasn't doing anything about it and I didn't have an answer. I of all people, have a reason to do something about it. And, so I have tried.

I attended what I believe was the first public hearing on the 009 site and was surprised when the EPA would not accept the because it would violate her privacy. I remember saying to the audience that now we know why EPA doesn't have any reports of problems associated with the site because they won't accept them when people try to hand them to them. I wanted to give the report to her because I did not think they would associate her condition with the site because my address at the time was north Glynn County. But, less than a mile from the site; and, met a carpool at Lanier Plaza next to Hercules to commute to Kings Bay to work. The next speaker after me was an instructor at the Federal Law Enforcement Training Center, where I worked at the time, who had recently had a baby born without kidneys and had died. Apparently I forgot to identify myself when I spoke, so she identified me for EPA (and I had signed in). But, on the transcript my name was spelt wrong [it was . at the time]. This meeting was the first time I had encountered Dr. Pegg who was the technical advisor for the Glynn Environmental Coalition. I already knew who Daniel Parshley was because I worked for the Deputy Director of the Federal Law Enforcement Training Center and recognized his name as a role player working for a contractor at FLETC.

By the time I attended the 009 Superfund Site hearing I had, had They were bused to which is less than a mile from the Hercules plant. Other than the fact that had to be at the bus stop at 7:00 a.m.; and, had to ride through the Marshes of McKay neighborhood before heading to Burroughs-Molette; and, that she typically threw up on the bus when she passed the Hercules plant; and, often arrived at school late after 8:00 a.m. Besides all that she basically adjusted well. Not long after she started school tarted a pre-school nursery program at which I think was less than a mile from the LCP site and Georgia Pacific Pulp Mill (as the crow flies). It wasn't until my children started school that I realized how sick our community was. By the time the at there was a kindergarten teacher, And, the . When she started high school there years later her social studies teacher who was the Georgia teacher of the year two years in a row had cancer.

Exemption 6 Personal Privacy

Exemption 6 Personal Privacy

 Exemption 6 Personal Privacy

Around this time there was an Office of Civil Rights (OCR) Complaint filed by a group I was a member of – Positive Action for Children and Teachers (PACT). The complaint was alleging racism regarding busing and how handicapped students were being served. The OCR agreed to investigate. One of the leaders who signed the initial complaint, Sandy Rumanek, told me that she was contacted and told that they had a limited budget and she should select one or the other for them to investigate. She told me they dropped the part about the handicapped students. The investigation was enlightening. At that time, St. Simons Elementary School on the island had televisions in the classroom (Which we thought was an advantage because they were not teaching reading phonetically so it helped to see the words of what was being said on closed caption.) ; Burroughs-Molette did not have televisions until right before the investigation; and then they weren't hooked up. At any rate, one of the investigators called Sandy to say that the report he submitted was not the one that she would be receiving and that he had resigned. The OCR did not find racism.

Like so many of the people in Glynn County who try to make a difference and can't, she moved. We had been attending school board meetings for a while and one of us had to run, so I did and won. I had been putting together what I had learned about the schools and their bussing and what I knew about the environmental hazards in the community and I concluded that there was environmental racism going on. I didn't want to file a complaint at that time because I didn't want to be tied up with that when I hear it was produced at Hercules in Glynn County. I filed a complaint with the OCR in Atlanta, but they selected not to investigate. So I filed a complaint with the Department of Justice alleging environmental racism and they did investigate. They intervened in the bankruptcy hearing which prevented LCP from being able to sell the plant which lead to their shut down. The Department of Justice never came back and told me that they found environmental racism, but the Atlanta Constitution Journal ran a story on Tuesday, December 28, 1993 by David Pace of the Associated Press entitled *Toxic hazards found worse near homes of blacks, poor* where he wrote:

> In Georgia's most polluted community, encompassed by the Brunswick ZIP code 31520, five plants spewed out 6.3 million pounds of 27 toxic chemicals in 1991. A little more than 21,000 people live in the area, half of them black and nearly a quarter below the poverty line.
>
> Among the chemicals released into the air, land and water in 1991 were 922,000 pounds of acetone and 523,390 pounds of chloroform, both known carcinogens, and 213,500 pounds of xylene and 52,000 pounds of methylethyl ketone, both of which are suspected of causing birth defects.

Over the years, I have followed the toxic sites in Glynn County and attended the public hearings that I was aware of. I served on the Glynn Environmental Coalition for four years after I got off the school board. I didn't always agree with Daniel Parshley and was very disappointed when Dr. Pegg told me in July 2009 that Daniel had fired him for not being responsive to emails. He said Daniel was sending emails to his old fccj.edu address, but the college name had changed and he had told him that it was now fscj.edu. I could not imagine how a new technical advisor could ever get up to speed with everything that had happened over the past ten years or more. I attended one of the meetings where the new technical advisor was introduced and was surprised to see so many in attendance. Several introduced themselves as being with the role players at FLETC.

I attended the December 4, 2014 public hearing about the proposed plan for Operable Unit 1; there was a meeting prior to the EPA hearing for the Glynn Environmental Coalition which I attended. At that point, it was hard to judge how effective the new technical advisor was, but once in the hearing the audience was bringing up things that Dr. Pegg could have spoken to because he attended the meetings with ASTDR, but the new technical advisor was not able to speak to. I left the meeting happy about the attendance and the fact that Mr. Killian had spoken up on behalf of our future grandchildren, but bewildered. After all in the beginning when people brought up wildlife that would be affected they talked about wood storks not dolphins. There is a big difference. One was protected at the time the plant was closed down and the other wasn't. It's bad enough that the federal judge dropped the wood stork charges in the federal hearing, but does the EPA have to forget about them too?

Conclusion

I read all 50 pages of the proposed plan and I believe the EPA did an excellent job explaining the process and explaining their rational for the preferred selection. But, I have also participated in decisions regarding contaminated school grounds and the other toxic sites in Glynn County and it seems like we never get a cleanup, we get a cover up. I thought just this one time we could actually get a cleanup. I prefer Alternative 2. I agree with Mr. Killian who cited concerns for future generations. I have read a book called *Now That You Know* by McGregor Smith, Jr. that talks about *The Seventh Generation Test* in Chapter 1, page 3:

> The Council reviewed decisions made by the chiefs. The old women sat in a circle and applied what they called "the Seventh Generation Test." They did not debate. They sat in silence and pondered the issue presented to them. Their question was simple: **"How will the decisions made by our chief affect our children seven generations into the future?"**

I'm asking you to review your decision and ask yourself the same question. Why should you do that? Because I believe the public participation component of the process has been compromised by the multiple changes in site manager for the LCP superfund site and the replacement of our technical advisor ten years into the process. I also believe that the whole purpose of the technical assistance grants in the superfund process is so that the community can be represented between industry and government. In this case, the government hasn't helped us. The federal judge dropped the woodstork charges in the LCP conspiracy prosecution [which I believe he did because if they prosecuted LCP for it they would have to prosecute all the other industries in Glynn County that were violating it.]. The Georgia EPD was responsible for enforcing the environmental laws in Georgia when these violations occurred. Of course they will go along with what EPA wants. Some of the lead we are talking about cleaning up might actually have come from the Glynn County Firing Range next to the site. The Navy had permits at Glynco to pollute the Altamaha-Brunswick Canal, an historic site which has not been considered in the cleanup.

Another way I believe the community has suffered and will continue to suffer with the proposed cleanup is with health insurance. When we apply for insurance we are asked three questions: 1) how old are you, 2) do you smoke or have you smoked within the last however may months or years, and 3) where do live. The last question factors in to how much we are charged for insurance and one of the things insurance companies take into consideration is the health status of the community. If the poison remains at LCP we will likely be charged more money to be insured. Which is just wrong since we paid for state and federal regulators to administer the environmental laws; and, we are punished by being sick or having babies with birth defects and we are punished again in attempt to stay healthy.

[redacted]

Please consider expanding

; current effort to clean

the Site of the former

.P. Plant in Brunswick, PA.

We believe the area of

ntamination is far beyond

r existing plan.

Exemption 6 Personal Privacy

[redacted]